AN EVALUATION OF MARKOV-TYPE MODELS IN

HUMAN RESOURCE DECISION SUPPORT

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Dedicated to

my wife Renu and daughter Shilpa

C E R T I F I C A T E

It is certified that the work contained in the thesis entitled "**AN EVALUATION OF MARKOV-TYPE MODELS IN HUMAN RESOURCE DECISION SUPPORT**", by Sushant Kumar Routray, has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

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NOTATIONS

k   No. of Grades in the Manpower System.

p_{ij} Probability that an individual in grade i at the start the time period is in grade j at the end of that period.

a_i Probability that a member of grade i at the start has by the end of the period.

i, j Grades in the Manpower System, i.e. $\langle 1, 2, \ldots k \rangle$

T   Transition Probability Matrix.

A   Attrition Vector, i.e. $[a_1, a_2, \ldots a_k]$

T Time Period

R(T)   Total no. of individuals recruited in time period T

r_i Recruitment proportion to grade i.

r   Recruitment Vector

$n_j(T)$ Number of individuals in grade j at time T

$n_{i,j}(T-1)$ Number of individuals moving from grade i to grade time $T-1$ to T.

$n_{0j}(T)$ Recruitment flow between time period $T-1$ to T.

$\bar{n}_j$ Expected or average value of each of the n_j s.

N(T)   Row vector of gradewise manpower at time period T.

N(T-1) Row vector of gradewise manpower at time period $(T$-$1)$.

$\hat{P}_{i,j}$ Estimate of $p_{i,j}$.

E   Expected total separations due to Attrition Vector

W   Anticipated Gradewise Wastage Vector for Future Years.

$\hat{w}$ Wastage proportions.

$(V_i)_T$ Anticipated no. of retirements in grade i duringtimeperiod

F   Adjustment Vector.

X   Forced outflow vector.

ABSTRACT

This work has aimed at exploring, developing, and evaluating quantitative paradigms to support recruitment, promotion, and attrition decisions in the human resource planning. Such decisions are complex and handled traditionally by intuition, prevailing practices, experience, and certain rules of thumb.

Data and policies in use spanning a nine-year horizon in a real enterprise employing 50,000 people were used to provide realism to this study. This enterprise had one special requirement to meet. It was considering introduction of automation on a large scale. Such changes would potentially affect the grade mix in skills, expertise, and experience. An immediate impact would be surplus HR and obsolescence, both on shop floor, and in the managerial grades. This situation might deteriorate due to the recruitment of freshly trained graduates to augment the employed expertise mix. Keeping growth and product innovation plans in perspective, top management—wishing to operate a set fixed grade structure for the managerial cadre—faced a number of complex policy choices that affect the inflows to managerial population, internal movements, and outflows from the system.

The present work approached these questions by designing an HR (Human Resource) decision model, using Markov transition type models proposed by Bartholomew [5]. The transition proportions would be estimated from real data. The model would be intended

to determine the controllability of what happens to the manpowe

pool when certain HR policies are adopted by the management.

The present work makes a departure from earlier models proposed t

help manage human resources by incorporating the controlle

treatment of attritions.

The model has been implemented on a spreadsheet by using the LOTU

1-2-3 package. The output data produced by this model appear i

both graphic and tabular format for easy comprehension, the inpu

being provided by human resource administrators needing t

evaluate alternate HR policies.

To facilitate entry of data to the model, a human resourc

information system (HRIS) has been designed which would maintai

the entire personnel database of managerial employees. It woul

also keep track of grade-wise men-on-roll, yearly promotions

and separations of employees. Additionally, it includes othe

features, such as the management of appraisal information ar

monitoring of training data.

CHAPTER 1

INTRODUCTION TO THE MANPOWER PLANNING PROCESS

Long range planning is a must except perhaps in the management of simple, temporarily constituted organizations. As businesses grow in size and diversity and attempt to cope with the challenges of technological change and new market opportunities, they must make increasingly sophisticated, long range evaluations of investment in products, facilities, and personnel.

Some aspects of the long range planning problem have been widely discussed and developed. Other aspects, however, have received less attention. Among the relatively neglected areas—one of perhaps critical importance—is **manpower planning**. Manpower planning includes a specification of the kinds and numbers of personnel an organization will need to attain its profit objectives and sustain it's growth or service objectives. Such planning produces a forecast based on existing personnel inventories of how well the organization is presently positioned to meet its projected needs and aspirations. It also produces a comparison of manpower needs with forecasted availability, and the formulation of plans for recruiting, assigning, and developing personnel.

1.1   WHAT IS MANPOWER PLANNING ?

— THE ISSUES,   DECISIONS,   AND CONSTRAINTS.

Manpower planning has been defined as a road map for the acquisition, utilization, improvement, and preservation of an enterprise's human resources.

Manpower planning aims to maintain and improve the ability of the organization to achieve its corporate objectives, through the development of strategies designed to enhance the contribution of manpower at all times in the foreseeable future [25]. Such strategies include:

(a) The collection, maintenance, and interpretation of relevant information about manpower,

(b) Periodic reports of performance relative to manpower objectives, requirements, and actual employment, and of other characteristics of the resource,

(c) The development of procedures and techniques which will enable all requirements for different types of manpower skills to be determined over a range of periods in light of known corporate objectives; and the modification of these objectives where they make unrealizable demands for manpower,

(d) The use, where appropriate, of techniques designed to result in more effective allocation of work, as a means of improving manpower utilization,

(e) Research into factors (which may be technological, social, or individual) that limit the contribution that individuals or groups can make to the organization, with the aim of removing or modifying such limitations,

(f) The development and use of methods for economic evaluation of manpower which adequately reflect its characteristics as income-generator and cost, and hence improve the quality of decisions affecting this resource, and

(g) The assessment of availability, acquisition, promotion, and retention, in the light of forecast requirements of the organization, of individual likely to perform well.

Manpower Structure in the present work is defined as the gradewise manpower population showing respective reporting levels., A key concern in HR management is to operate the enterprise with an optimum manpower structure under varying conditions.

1.2   MODELS TO ASSIST IN MANPOWER PLANNING.

A survey of the recent literature on the techniques of manpower planning reveals the advocacy of two major approaches, namely, mathematical modeling, and the application of simulation techniques. These two methods have been noted to be especially capable of effectively guiding manpower planning decisions.

The first of these, the mathematical modeling approach, involves the development of simple *stochastic* models to address "flow" aspects of the planning problem, and the exploitation of these aspects by direct mathematical manipulation. Such an approach clearly requires that the model be a close representation of the real problem—amenable to mathematical and computational methods known. However, since there are manifestly a great many complex interactions and effects present in real manpower planning situations, a comprehensive and satisfying model that recognizes all of them might be beyond mathematical methods alone. The second approach simulates on a computer the histories of a manpower system under different input policies and environmental conditions. Eventually the mathematical and simulation approaches may be blended, allowing the user to benefit at once from the crisp conceptual form of the former, while maintaining the comprehensive and evocative character of the latter [11].

1.3 GROWING INTEREST IN THE FORMAL PLANNING OF MANPOWER.

The simplest and oldest approach to manpower planning is perhaps the so called *replacement table* method [25]. The replacement table shows the list of men or group of men presently in the system, organized by function and job level, and it provides a description of the current inventory. The main problem, according to this approach, is to ensure that when men quit, retire, or die, suitable candidates will be ready to move into their jobs. Age data lets retirement statistics to be predicted with precision and coupled with historical information, general actuarial data, and estimate about future needs. It also permits estimation of losses due to other reasons. Thus, rough estimates can be made with the replacement table of where and when vacancies will occur.

The replacement table method is effort—intensive for its execution by hand computation. Also, it reflects only a static rather than a dynamic picture of an organization's structure and needs. Several other approaches have come about since 1945 in response to the variety of decision problems faced by numerous industries and government organizations [12].

During World War II, shortages of manpower made human resource planning at the national level a necessity. This was undertaken by the War Manpower Commission in USA, which in turn required individual firms in the USA and Great Britain to submit regular reports on their current manpower inventories and future

problem found the Markov Chain paradigm to be an effective technique for predicting the distribution of personnel [40]. The other techniques proposed were linear programming [33], and network analysis [16]. The Markovian model has been considerably elaborated to include the effects of key policy decisions in managing personnel systems [6].

1.3.1   USE OF MATHEMATICAL MODELS.

Andrew Young and Gwen Almond were the pioneers to use mathematical models for predicting the number and distribution of staff among various grades in future years for an institution which had expanded very rapidly since the end of World II [37]. They showed the long term consequences of assuming the persistence of present patterns of recruitment and promotion into the future, i.e, assuming that inflows and movements to the next higher grades are stable. While it is unlikely that a scenario will persist for several decades, mathematical analysis can give advance notice of the necessity for changing staffing policies [38].

Two years later, William Gorham suggested the application of a *Network Flow Model* to manpower planning in U.S. Air Force. This model decides the best pattern of training and retraining activities that should be undertaken to ensure that properly trained personnel are available when and where needed, at minimum cost.

A particularly difficult aspect of personnel logistics prevailing
was that of programming training and retraining activities for the
US Air Force, where the "employer" trained most "employees" for
specific military skills. Varying lead times, uncertainty in
requirements and losses, and the numerous alternative ways of
meeting new or increased specialty requirement were only few of
the factors which contributed to the difficulties.

The Network Flow Model casts the problem in terms of nodes which
represent individual specialties in specific time periods, and
links of which represent all potential training and retraining
flows. By using one node for each specialty in each time period,
a dynamic flow is simulated by static network. The solution
yields the set of flows over nontraining, training and retraining
links which maximizes the aggregate value of the network, the set
of flows which results in the best match of expected available
manpower to projected requirements. The details of this model is
described in [16].

In 1973, Davis[37] brought forward the concept of exercising
controls on the parameters of a Markov Chain model of a graded
manpower structure. He suggested that control could be exercised
through three main aspects of the manpower system :

    (a) The rate of loss from system,

    (b) The proportions recruited into each grade, and

    (c) The promotion and demotion rates.

When management requires a change of structure in its organization, control is generally imposed on requirement, promotion, and demotion rates [37]. It may be possible under these conditions to move from given personnel structure to a "goal" structure, through a set of steps. Once the target structure is found to be attainable, the question of its maintainability arises. Every structure is maintainable if all the parameters can be controlled and care is taken to formulate policies which are effective and enduring.

S. Vajda, in 1975, applied the concept of linear programming in particular the Simplex and Dual Simplex Algorithms for the development of a graded population, when transfer rates between the various grades are given, and "wastage" is replaced by suitable recruiting [38]. The following aspects are dealt with by Vajda:

(a) Which population structure (i.e. partitions into grades) can be attained from a given structure, after one or steps?

(b) From which structures can a given structure be attained in one or more steps?

(c) If the present structure as well as a desired future is given, can the latter be attained from the former in one or more steps? If so, how?

Vajda assumed that transfer and wastage rates are given, independent of time, acting at discrete time intervals, and that control is exercised by choosing appropriate recruitment rates into various grades.

The above work has been extended by Silverman et al. [33] by using a multi-period, multiple criteria optimization system for manpower planning. This approach is used to identify recruitment and promotion strategies for managing the enlisted force of the U.S. Navy. With the criteria modeled as trajectories of goal values over multiple time periods, the system uses the interactive augmented weighted Tchebycheff method [33] as its solution procedure.

One class of manpower planning problems which Silvermam et al. have intensively studied is that of recruitment, or accession planning. In accession planning one is concerned with the selection of a recruitment schedule over multiple time periods which best meets goals pertaining to promotion opportunity, salary expenditures, desired levels of experience in the work force, and recruitments of manpower in each of the planning periods.

In a prototype model the above authors examined recruitment and promotion policies of the U.S. Navy for a force with eleven length of service (LOS) categories. Retirement is mandatory for all individuals after completion of the eleven periods of service. Entry into the force can take place only into the lower two

grades, with fixed proportions, in the form of a *recruitment assignment vector*. The status of the Force at any point in time can be represented by a *personnel inventory matrix*.

Four types of flows of personnel occur that are of central interest in manpower planning. These are, respectively, losses from the Force, recruitments, promotions, and demotions. Recruitments and promotions are decision variables determined by the model in response to the trajectories of goals placed upon the system. In contrast, losses from the Force and demotions are calculated from a *transition matrix*.

There are seven trajectories of goals in Silverman's model. However these trajectories are typically in conflict with one another, making it impossible to attain all goal trajectories simultaneously.

The (multiple) objectives are :

- minimize salary expenditure,
- maximize total strength,
- maximize promotion, and
- maximize mean length of service.

subject to :

- salary constraints,

- paygrade strength constraints,

- promotion opportunity constraints,

- mean length of service constraints, and

- total strength in final period constraint.

The model generates multiple solutions and displays them using computer graphics. It is also possible to absorb large amounts of multiple criteria information at each iteration. These enable us to eventually converge to a final problem statement while, at the same time, converging to final solution of the problem as a whole.

1.3.2   SIMULATION MODELS.

The foregoing models are usually treated in a deterministic fashion, making no allowance directly for inherent uncertainties of the flows. Implicit in any real process of personnel movements through a hierarchy are a set of decision rules. These decision rules may be classified as either structural, policy, or individual rules. The structural category refers to rules which modify and control the structure of the organization. This would include rules for creating or abolishing positions, ranks, or departments. It would also include rules about flows of

information, influence and products.

In order to model personnel flows, and to manipulate the models either mathematically or by computer simulation, it is necessary that one keeps the decision rules explicit, simple and operational. When the model becomes complex, computer simulation acquires immense value. In particular, the model can be validated for those variations actually tested. However, validation of the model as a whole requires exhaustive testing of all the alternatives —a monumental task. Furthermore, simulation is unique in that it accepts explicit statistical variations into the model. In addition, it accepts uncertainty also in the selection of appropriate tests and measures for comparison of results. As the best utilization of simulation, Markovian and traditional statistical manpower planning models, it is suggested that these alternative techniques be used as variations of the basic personnel flow model [12].

1.4   DECISION AND INFORMATION SUPPORT NECESSARY FOR MANPOWER PLANNING.

Almost all data available to manpower planners in large organizations are cross sectional [17], i.e. data flows from various sections in the organization. The organization's data are kept, at least initially, to aid in the organization's routine operations that are closely tied to some fixed accounting practices and reporting intervals (for example, payroll records

and the fiscal or tax year). Manpower data files contain
information on personnel at some particular time, and on the
manpower requirements at this particular time. For administrative
purposes, personnel actions such as promotions and retirements
often are effective at the end of some accounting period, and it
is very important to know precisely the time period to which the
data refer. Besides, Power et al. [17] suggest that the accuracy
and completeness of input data will largely determine how much
confidence users will have in a model's results. Also they stress
the importance of user-friendly input interface design for the
sophisticated computer-based planning models.

Amongst the most widely used database structure for manpower
planning is the *relational* data model, which has many advantages
that supersede the hierarchical and network data models [30,36].
The relational model of data was first proposed by E.F. Codd in
his pioneering paper "A Relational Model of Data for Large Shared
Data Banks" [4]. Codd showed that to be effective and efficient
the database should be a collection of tables which he termed
relations. Each relation in turn consists of rows or "tuples"
(equivalent to records in the traditional notion of database) and
attributes (synonymous to the notion of fields in records),
arranged as columns in the relations.

Often, however, there is considerable redundancy in the tabular
"flat file" presentation of data within one relation. Further,
there may be insertion and update anomalies at the time of

storage, modify, and delete. Codd devised a process which he called *normalization* to help eliminate these drawbacks. He also proposed a relational language structure whereby data represented in relations could be conveniently manipulated.

An extension of relational database model of the 1980s is the *object oriented database* of 1990s that supports schema evolution, queries, concurrency control, storage structures, and indexing. It is expected to handle complex data types which may not be handled by relational model, [34]. But the object oriented database is still at its infancy and its application to manpower database is yet to be evolved [36].

1.5 THE PRESENT WORK.

This work has aimed at evaluating the existing and developing new quantitative paradigms to support recruitment, promotion, and attrition decisions in the HR planning process in large enterprises. Such decisions are complex and handled traditionally by intuition, experience, and perhaps some rules of thumb. The present work has utilized Markov type transition models as proposed by Bartholomew [6], for developing manpower plans.

Also keeping in perspective the real life needs of the subject industry, a *Human Resource Information System* (HRIS) has been developed and implemented in dBASE IV using a relational database structure. This database provides input data to support the decision maker's use of the manpower planning model.

CHAPTER 2

HR DECISIONS AND DECISION SUPPORT SYSTEMS

2.1 MANAGERIAL DECISIONS AND MIS.

Decision making is perhaps the most basic responsibility of managers. As one goes up the ladder, the complexity and pace of decision making rapidly increases. A manager generally has to sift through a large veriety and volume of information. A well developed DSS can act as an effective aid in such a juncture.

Decision Support Systems (DSS) came into being through the evolution of information systems. The pioneering step of this revolutionary information era was EDP (Electronic Data Processing). This dealt with the transaction processing type of applications which were cumbersome to do manually. In the mid 60's, the term MIS (Management information System) was coined to signal a new attempt to develop integrated computer base information systems that were capable of processing and supplying all information needed by management. To complement EDP and also to shift the attention away from MIS [13], the term DSS was introduced in 1978 by Keen and Scott Morton to denote the other aspect of information processing — the provision of information for supporting management decisions on semi-structured or unstructured problems in order to improve its effectiveness.

2.2 CHARACTERISTICS AND COMPONENTS OF A DSS.

In general, a DSS has the following characteristics that distinguish it from the multitrends of other applications of EDP capabilities, [13].

i) DSSs provide most value when aimed at the less well structured, under-specified problems that upper-level managers typically face. These are not the routine decisions. Such decisions may involve policy evaluation, strategy development, and risk analysis.

ii) DSSs combine the use of enterprise and decision models or analytic techniques with the traditional data access and retrieval functions of a DBMS.

iii) Such systems specifically incorporate features such as user friendliness that make it easy for non-computer initiated people to use DSS, frequently in the interactive mode.

iv) The structure of such systems emphasizes flexibility and adaptability to accommodate changes in the environment and the decision making approach of the user.

v) DSS aims at supporting but replacing upper level managers in decision making. A good DSS can replace lower and mid-level planning support staff, however, by automating such aspects as scenario and sensitivity analysis.

The components that any integrated DSS should incorporate are as follows [1, 22] :

(a) *Decision models* —sets of analytical,optimization,and data processing routines to generate decision support information and the relations between decisions and their consequences for decision making, which otherwise would only perhaps remain in the mind of the decision maker,

(b) *A decision modeling language that is user friendly,*

(c) *Interactive computer hardware and software to make the system easy to use,*

(d) *A database—* depository of raw data organized in an optimal logical format, which is invoked by the system for decision analysis,

(e) *A database management system* — to help in coping with data organization and access problems, and improve the communication of the information available for management decision making via an appropriate user interface or query system,

(f) *Graphical and other sophisticated displays to improve interfacing with the user.*

3.3 DECISIONS, SUPPORT AND SYSTEMS.

The word "decision" in DSS implies problem solving with the use of knowledge which is applied in the form of models. The support aspect of aDSS implies the use of computer and software technologies to support managers during the decision making. There are four types of support that can be provided to decision makers [13] and are summarized below:

(1) *Passive Support:* Providing decision makers with a DSS that they are comfortable with to allow them to make autonomous decisions.

(2) *Traditional Support:* Providing support to decision makers to mesh with the their judgements and their refinement.

(3) *Extended Support:* Decision alternatives are actively suggested by DSSs to decision makers.

(4) *Normative Support:* DSSs here dominate the whole decision process, with managers providing primarily the inputs and solution specifications.

2.4 DEVELOPING AN EFFECTIVE DSS.

Meador, Guyote and Rosenfeld [1] proposed a four stage process for developing a DSS. These are decision support analysis, DSS software evaluation and selection, prototype development, and

operational deployment and support. The details of these steps may be stated as :

i) **Decision support analysis**

- structured interviews
- decision analysis
- data analysis
- technical analysis
- conceptual DSS orientation
- plans and prioritization

ii) **DSS software evaluation and selection**

- identification of candidate softwares
- feature analysis
- benchmarks
- external site surveys

iii) **Prototype development**

- Scoping of prototype
- project evaluation criteria
- detailed design
- system construction
- testing
- demonstrations to obtain user feedback
- evaluation and refinement

iv) Operational deployment and support

- functional orientation

- operational training

- deployment

- maintenance

2.5 MAKING DSS USER-FRIENDLY.

Ergonomics helps a designer of DSS to make its model more acceptable and user friendly. Following are some of the recommended steps in this direction [15]

(1) Minimum effort by user.

The user should be required to perform only that work which is absolutely essential and cannot be performed by the system.

Data should not have to be entered more than once, program code should be reusable, as should query or command procedures, file and data definitions, and so forth. Nonproductive work should be eliminated.

The user should not be required to search for system information. Documentation should be available on-line in the form of help routines.

Duplication of work should be eliminated. No paper work be asked for in between.

(2) *Minimal taxing of user's memory.*

The user should be required to use his/her memory only when it is absolutely necessary. The DSS should be designed so that learning the system is an incrementally extensible and hierarchical process. Commands used by the user should be in natural syntax form and should be simple rather than complex or compound.

(3) *Minimum user frustration*

The system should spare the user frustrations that may arise from a delay in the accomplishment of a task. If menus, prompting, or other guidance techniques are used, the system should permit the experienced user to bypass them. Guidance or help should be available to the novice user in a consistent, logical fashion though the entire decision support session.

The user should be able to interrupt or terminate a program execution at any point and select another activity. After completion of the second activity, the system should permit resumption of the interrupted activity at the point of interruption, by simply pressing one or two keys.

(4) *Maximizing the use of habit patterns.*

A DSS should respond to the human tendency to form both long and short-term patterns of action. The system should take advantage of "muscle memory" by consistently using certain function keys for specific functions, by consistently placing similar information on the screen in the same position, by consistent design of screen formats, and so forth. Information returned on a screen to a user as the result of his/her action should be positioned at the point where the user expects the response — usually on the next following line.

(5) *Maximum tolerance for human differences.*

A DSS should be designed to accommodate the fact that people think differently. Therefore, it should provide visual and audible attention-getting methods, selectable by the user. They may include highlighting or blinking signals on the screen, a buzzer, or a bell, etc.

(6) *Maximum tolerance for environmental change.*

The system should support, with minimal user effort, change of the hardware/software environment or changes to applications as a result of new functional requirements. Application programs should be compatible and transportable among different models of computers available.

(7) *Maximum worker control of task.*

The user should control the flow and sequence of work to the maximum extent possible where there are no sequence-dependent activities. He should be able to define 'default' options for giving tasks and have these options remembered by the system for future use.

The above ergonomic considerations are not an exhaustive list but these are some of the major ones that makes a DSS truely effective.

2.6 WHAT IMPEDES ADOPTION OF A DSS BY MANAGEMENT?

(1) *Computer literacy and training requirements:*

Although the proportion is rapidly increasing, few managers even today can manage working with computer terminal on their own. They need handholding, support, and special training to effectively use a DSS.

(2) *Data capture and collection:*

How to capture and collect data to be put in the DSS database remains an unsolved problem [13]. Many DSSs are not compatible with each other, forcing decision makers to retype

data and thus creating unnecessary duplication of data and efforts and also introducing errors. Problems also arise from the non—compatibility of purchased DSSs with existing databases and computer networks.

(3) *Data integrity and security:*

Duplication of data poses a data integrity problem whereby data are at different cycles of update. Furthermore, the scattering of sensitive data at different places poses a problem of security, problem which becomes hard to manage.

(4) *Unstructured problems:*

There is a need to extend DSSs to solve unstructured problems that are commonly faced by top executives entrusted to make vital decisions.

(5) *Management of DSSs:*

With small DSSs built and forgotten, and large DSSs constantly under modification without proper documentation, there is a real need to manage the process and product of DSS development. Otherwise the whole thing may run out of control, especially when the key developers quit the organization.

(6) *Cost-effectiveness:*

Is a DSS cost effective? Clearly some justifications are needed before committing personnel and monetary resources to the development of a DSS. The traditional cost benefit analysis may not be the best approach for assessing the benefit at an innovation. However, one must find a better way of assessing oppertunity cost depending on his requirements.

(7) *Standardization:*

There is a need to standardize some basic features of DSS so that they can be used by more decision makers while taking into account individual differences in terms of decision making styles.

(8) *Individual versus group DSSs:*

How to support individual decision makers during a group meeting is also a pressing problem. Should all individuals use the same DSS and see the same thing, or should individuals be allowed to use their tailor-made DSSs during a group decision making?

(9) *Data are not independent of spreadsheets*:

Data used by one spreadsheet normally cannot be used by a different spreadsheet, resulting in pieces of data being tied up with separate spreadsheets. An agreeable industrial standard for all spreadsheet may not come easily.

The future trends [13] in the development of DSS are in the direction of Group DSS, Decision Support Center, DSS for supporting strategic management and adoption of artificial intelligence (AI) and expert system techniques. For years to come, however, DSSs will continue to play a pivotal role in offering implementable solutions to complex managerial decision making environment.

CHAPTER 3

HR INFORMATION MANAGEMENT

3.1 DATA AND INFORMATION.

An organization in its day-to-day operations accumulates and processes various types of data—related to its business and the environment. The result is the **information** it generates to take strategic, tactical and operational decisions. Data is thus viewed as the raw material with which we start and information is the processed data which is used to trigger certain actions or gain better understanding of what the data implies. The same data may be processed in different ways to obtain different types of information as required by different levels in the hierarchy of organization. Data is mostly processed manually when the organization is small and also the volume of data processed is small. With the increase in volume of data and enhanced pace of information requirement, it becomes necessary to resort to computer based information system. And also many trends in the development of industry and commerce have computer-based information systems essential to efficiently run organizations. Significant among these trends are the following.

(a) The size of organizations is becoming larger. This is also true in developing countries due to their rapid and large scale industrialization.

(b) Computer-based processing now enables the same data to be processed in many ways, based on needs, thereby allowing managers to look at the performance of an organization from different angles and objectives.

(c) As the volume and the variety of information grow and their timeliness rises in importance, computer-based information processing has becomes essential for efficiently managing organizations.

(d) Many Organizations are now branched out geographically, far apart, and require faster data transactions for their routine operations.

(e) Markets are becoming more and more competitive, demandingrapid reaction.

(f) The general socio-economic environment now calls for statutory information for consumer groups, financial institutions, compliance to Government norms, environmental protection activities, etc. Many of these were not existing earlier.

All these developments require decision making based on up-to-date, well organized, and accurate information, rather than rules of thumb, and hunches as employed in the past. Today Some of the major functional information processing systems operating in organizations provide comprehensivesupport for human resource management, materials management, finance management, and

production and distribution management.

In a climate of stability and growth when manpower shortages in number and the mix of skill may impose restrictions on achieving business objectives, the case for improving the efficiency of personnel administration systems can be easily made. In a climate of changing technology also changing manpower requirements impose a high demand for quality decisions that are often added by computerization of human resource information.

3.2 HUMAN RESOURCE INFORMATION MANAGEMENT BY HRIS.

The primary goal of HRIS (a computer based human resource information system) is to provide personnel information which is appropriate to the needs of decision makers, comprehensive and timely. This enables management to focus attention on areas where its actions will yield best pay off. It is necessary to enumerate the types of information relevant here.

i) Strategic Information (these have long term bearing)
. Long range human resource requirements at different levels
. Policies on compensation packages
. Policies on HR development and training
. Policies on employee welfare and amenities.

ii) Tactical Information (these help implement the strategies)

. Performance appraisal

. Demographic pattern of personnel and its impact on retirement

. Production incentives and relation to productivity

. Employee morale

. Absentee reduction

. Leave and overtime rules

. Personnel deployment policy

. Recruitment/employment and growth

. Skill acquisition and shortages/surplus

. Succession and growth plans

. Acting/seniority chart

. Job enrichment plans

iii) Operational Information (aiding day—to—day conduct of
     resource management)

. Routine assessment

. Skill inventory

. Loan/advance recovery

. Leave records

. Reward/punishment history

. Training needs and training imparted

. Screening details

. Medical history

. Service details and history

. Turnover analysis

. Recruitment/employment tracking

In order to provide "information I need" as desired by the various respective users, an integrated HR system approach should be evolved based on 'critical success factors' (CSF) [31], relating soundly to the organizations goals and priorities. Since CSFs are manager—specific, they should help in identifying the nature and amount of information that must be generated by the system and thus limit the costly collection of more data than necessary. The typical Human Resources Critical Success Factors are

i)   Enhancing the organizations ability to attract and retain quality people.

ii) Strengthen and heighten image and reputation in employment markets.

iii) Maintenance of high employee morale.

iv) Facilitation of employee innovation and freedom to act.

v)   Line managers with effective personnel skills.

vi) Improved productivity through people.

vii) Cost effectiveness of HR programs.

3.3 QUALITY ASPECT OF HRIS DATA.

The quality of data in human resources information system (HRIS) databases in some respects a philosophical issue. That is, the 'quality' of the information about people and jobs that resides in the HRIS frequently lies "in the eyes of the beholder" and can be called "good" or "bad" only in the context of business requirement or an individual HR manager's perception of "what is right" in

terms of data accuracy, timeliness, or significance of the data conveyed. However, to generate information of value and relevance which will address real needs of the user, the HRIS manager must stand in the shoes of those who use the data in the HRIS.

The two most common reasons given for not producing quality HR management information are (1) a lack of understanding of what constitutes quality information and (2) lack of access to the appropriate computer tools.

There are many standards for defining quality information [3,23]. In the order of importance, the five most critical standards are the following:

    i)   Data accuracy,

    ii)   Significance and relevance,

    iii) Comprehensiveness,

    iv)   Readability and visual impact, and

    v)   Consistency of format.

Data accuracy

If the data are inaccurate, the information generated from them will have little or no value. However, HR data do not necessarily have to be 100% accurate for them to be useful as a basis for management information. A 1% error rate may be perfectly acceptable to a manager who wants information on the overall trend

of salary costs over the previous five years; on the other hand, errors may be intolerable to someone who wants a detailed employee salary listing.

Therefore, the standard here for data accuracy may very well be defined by the user's expectations and by the ways in which the user intends to use the resultant information. Other factors that greatly influence data accuracy are the timing of inputs and batch updates. Summary-level reports are also another area in which accuracy plays a major role. If data presented are inaccurate or contain mathematically impossible figures or charts, they call into questioning the validity of the *total* information being passed.

Significance and relevance

A common complaint often heard about HRIS from line managers is that they continue to get the information they don't need, and do not get the information they actually need. The reports sent to senior managers many a time find their place in the waste paper basket as they do not directly aid the managers in taking HR related decisions.

Meeting the significance and relevance standard involves providing the right HR information to help answer the most important management questions. An effective requirement analysis ostensively helps in achieving this end.

Comprehensiveness

Another common problem that the HR department encounters when providing information to senior management is that its reports often generate more questions than answers. This is especially true when reports are presented as summaries. Such questions usually involve: why cost per fresh recruits are going up day-by-day? Why are we not able to retain our young recruits? Why are we behind schedule in re-deploying our surplus people to the needy departments? etc. etc.

The essence of the comprehensiveness standard may be stated as follows. Quality HR information should provide a complete picture of a business problem — and possibly offer alterative solutions. It is not enough to show *what* is occurring; the report should tell *why* some thing has occurred and *what* actions are necessary in light of the situation.

For HR information should accomplish the following to be considered comprehensive [3]:

i) Answer not only the immediate question, but the follow up questions as well. (Some questions should be anticipated.)

ii) Provide insight that may not otherwise be clear from the "numbers", and

iii)Provide suggested answers. (not merely generates more questions.)

Readability and visual impact

A HR report or query — based display on the computer terminal loses its importance unless it is **ergonomically** designed. The contents must be spaced properly in order to avoid strain on viewers and confusion. Wherever possible, a table must be accompanied with **graphs**. These graphs should be selected based on the information and message need to be conveyed to the audience. The use of colour in graphics is generally considered beneficial because colour attracts and holds one's attention. However, colour is most powerful when it is used to highlight specific pieces of information, to group pieces of information together, to delineate lines in a line graph, and/or to visually code data. One drawback of colour is that a few individuals are colour-blind. This problem can be avoided by asking about these difficulties in advance or by using patterns to differentiate the graph elements.

The development of quality HRIS is an ongoing process of review, evaluation, modification, and implementation of HR information management practices. They are gradually evolved to what they are today.

After the successful testing of an HRIS, it has to be properly documented for future reference and further development of the existing scope and work. This also helps in maintaining good HRIS performance.

3.4 ORGANIZING FOR HRIS DEVELOPMENT.

The actions taken before final implementation often play a critical role in determining success of a new HRIS. This is the time to face all those organizational bugaboos that till now HRIS managers have been sweeping under the rug. It's now time to plan in detail how the implementation process will proceed: Which modules should be installed first? Who is going to make data entries? How do we gear up our staffs and users for the coming revolution?

The following are some of the steps generally recommended by information technology professionals in order to ease implementation of new information systems and enhance the system's effectiveness:

i) Before beginning, update, revise, and/or rewrite institutional policies and procedures — with the action involvement and support of users.

ii) Select the implementation team, and assign a clearly defined role to each member, under the overall supervision of an HRIS manager.

iii)Define how the information developed will be disseminated throughout the organization.

iv) Prepare validation criteria of necessary data

v) Plan the implementation schedule

vi) Assess the changes that will occur in the daily routines in each affected department and start appropriately orienting these employees in these areas.

Preventive trouble—shooting can go a long way towards keeping disruptions in implementation of the new HR system to a minimum, and in making the transition smooth and painless for every one. The payoffs of computerizing HR decisions support can be big.

CHAPTER 4

MODELING HUMAN RESOURCE FLOWS BY MARKOV CHAINS

A Human Resource System may be modeled as a set of interconnected stocks and flows between them, to facilitate both understanding of the changes in the states of this system and the evaluation of strategies for influencing these changes in desirable ways by incorporating the equivalent of restraints under which a real organization operates.

When one sets out to model a human resource system by using formal approaches of Markov chain type, one begins by identifying which stocks and flows are predetermined (not subject to the decision maker's control), and which are not.

The following questions serve to exemplify how transition matrix type models may serve productively in the handling of practical manpower planning problems:

(a) What will the grade structure be at various points in time in the future if present pattern of attrition and promotion continues?

(b) What should the promotion rates and recruitment numbers be, to help achieve a desired structure or distribution of personnel over grades in a specified time frame?

(c) What impact will expansion or contraction of the organization have on the promotion prospects or on the grade structure (population by grade)? What can be done to anticipate and minimize any ill or undesirables effects of such changes?

(d) Is there an ideal "age structure" for a particular organization?

A manpower model for this discussion is a mathematical description of how change may occur in the system. Such modeling begins with the specification of the constraints under which the real system operates. Secondly, a model must specify the mechanisms which generate flows, such as promotions or demotions—generally under the control of managers—and voluntary wastages that are not under direct management control. Also there may be assumptions about the future levels of manpower in the different grades. These are often based on a blend of historical data and management prerogatives and policies.

Assumptions about personnel flows may be classified variously Two such classifications commonly noted in the literature are: *stochastic/deterministic* and *push/pull* [17].

4.1 STOCHASTIC/DETERMINISTIC VIEW OF FLOWS.

If we assume that exactly 10 percent of those in a particular grade would leave in a given year, then we are making a

deterministic assumption about that flow. Here there is no uncertainty about how many people will actually leave. If, on the other hand, we were to suppose that each individual in the grade had a 10 % probability of leaving sometime during the year, then we would have made a stochastic assumption as we could not predict precisely how many would leave, but only the probability of departures.

4.2 THE PUSH/PULL NATURE OF FLOWS.

Flows may also be classified according to whether the impetus for a personnel move lies at its starting point (from which the individual is departing) or at its destination. Thus if an individual moves into a higher grade *because* it was necessary to fill a vacancy arising at that level, we can think of the person as being pulled into the higher grade. If on the other hand, the move to the higher grade is automatic as a result of acquiring a new qualification the move takes place because of an event occurring at the point of origin, such flows are called *push* flows. The distinction between push and pull flows is often not as clear-cut as this account might suggest. There can, for example, be both a pull and a push element involved in a move when a vacancy arises which can only be filled by a suitably qualified person.

In the stochastic case, push flows are modeled by specifying the probability of the transition event in question. In the case of a pull flow, a move is determined by the creation of a vacancy together with the choice of an individual to fill it. There may be a chance element at either or both of these stages which can be expressed in probabilistic or stochastic terms. In a deterministic model the flow probabilities are replaced by proportions.

4.3 ASSUMPTIONS BEHIND TRANSITION FLOW MODELS.

A model is essentially a description of the system together with a set of assumptions about the behavior of the uncontrolled variables or the environment. Such assumptions may be based on two kinds of considerations which may be described as *empirical*, or as *hypothetical*. By an empirical assumption the desired results are derived from past observation of the system. This amounts to supposing that the observed trends or patterns seen in the past will continue into the future. In many planning situations, however, we are less interested in projecting the past. Rather, we wish to explore a range of possible futures. That is, we are often seeking the answers to "What if...?" questions. In these circumstances we often find it useful to observe and evaluate the effects of assuming, for instance, different probability levels, because of the insight it gives us into the behavior of the real system. Such exploration is guided by the manpower planners making hypothetical assumptions

The empirical observation that personnel flows are proportional and perhaps dependent on stocks at various grades is a common one and this provides the basis for the professionally recommended use in manpower planning of so-called Markov Chain type transition flow models, as elaborated below.

4.4 CONSTRUCTION OF A MARKOV-TYPE HR MODEL.

In constructing the Markov chain model, the system is divided into k categories or <u>states</u> which, for brevity, but without loss of generality, would be synonymous to <u>grades</u> in a manpower system. The *probabilities* of a transition or transfer between any pair of these grades may then be set out in an array or matrix, as follows:

$$
\begin{array}{c}
\text{Transition} \\
\text{Probabili-} \\
\text{ties.}
\end{array}
\left[
\begin{array}{ccccccc}
p_{11} & p_{12} & . & . & . & . & . & p_{1k} & a_1 \\
p_{21} & p_{22} & . & . & . & . & . & p_{2k} & a_2 \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
p_{k1} & p_{k2} & . & . & . & . & . & p_{kk} & a_k \\
0 & 0 & . & . & . & . & . & 0 & 1
\end{array}
\right]
\begin{array}{c}
\text{Attrition} \\
\text{Probabili-} \\
\text{ties.}
\end{array}
$$
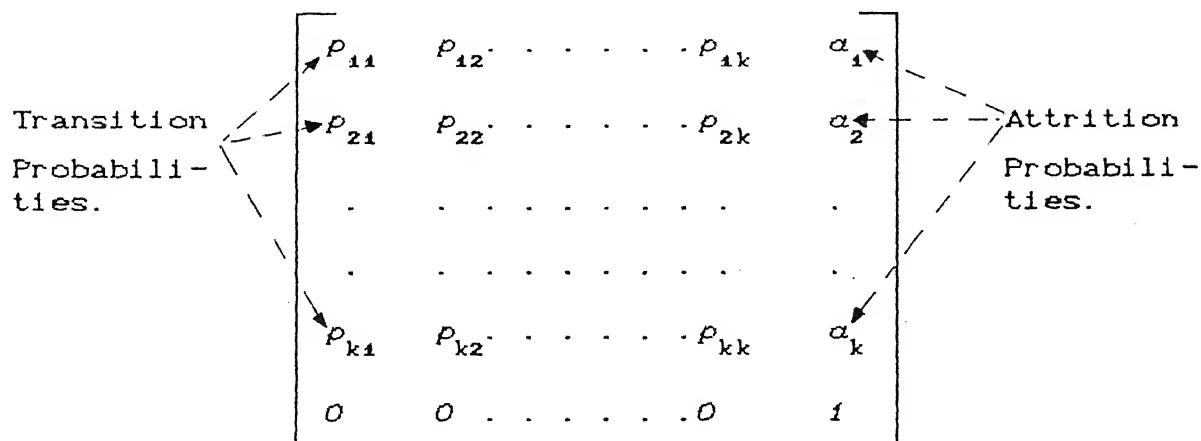
where the element p_{ij} is the probability that an individual in grade i at the start of the time period (say year 1) is in grade j at the end of that period while a_i is the probability that a

member of grade i at the start has left by the end of the interval
(the beginning of year 2). These chances of a transfer are known
as *transition probabilities* in the stochastic model, and
transition proportions in the deterministic model. The
assumptions for the Markov chain are that individual employers
(making up the population in a given grade) move independently and
with identical probabilities that also do not vary over time
[5,6]. Since each person must either stay where she or he is, or
move to another grade, or leave, each matrix row sums to 1 as

$$\sum_{j=1}^{k} p_{ij} + a_i = 1 \qquad \forall\, i. \qquad \dots\dots\dots(4.1)$$

Here matrix $T = \{p_{ij}\}$ is called the *transition matrix*, and the
row vector $A = \{a_1, a_2, \dots, a_k\}$ is called the *attrition vector*,
made up of attrition probabilities for a given grade. It is
implicit in this specification that the time is discrete; in
practice the unit of time will typically be a year or month.

The addition of attrition probabilities is a key departure in the
present work from the model proposed by Bartholomew.

The elements of T and A will have numerical values in any modeling
application, specified by hypothesizing the values of $\{p_{ij}\}$ and
$\{a_i\}$, or by estimating these probabilities from the past data.

In a realistic HR model we also have to specify "recruitment" flows (the inflows into the different grades of the manpower pool), by indicating that the <u>total</u> number of individuals recruited in the time period T be denoted by $R(T)$. These recruitments are assumed to be allocated to the different categories (grades) using proportions $r_1 r_2 \ldots r_k$, where $\left(\sum_{i=1}^{k} r_i = 1 \right)$. $r = \left\{ r_i \right\}$ is called the *recruitment proportion vector*. The use of r in the total manpower model is shown in equation (4.5). $R(T)$ and $\{r_i\}$ are typically controlled directly by management.

4.4.1 TRANSITION EQUATION.

The details for developing Markov type models for manpower systems are provided by Bartholomew [6]. The assumptions in Bartholomew's model are

 (a) The transition probabilities do not vary with time.

 (b) The transition probabilities are the same for all individuals within a class/grade.

 (c) The individuals behave independently and that transition probabilities are functions of the current state only.

The flow process here is represented by the equation

$$n_j(T) = \sum_{i=1}^{k} n_{ij}(T-1) + n_{0j}(T), \qquad \left(j = 1, 2, \ldots, k \right)$$

$$\ldots \ldots \ldots (4.3)$$

where

$n_j(T)$ = Number of individuals in grades j at time T,

$n_{ij}(T-1)$ = Number of individuals moving from grades i to j from time $T-1$ to T,

$n_{oj}(T)$ = Recruitment flow between time period $T-1$ to T,

k = Number of categories/grades in the manpower system.

The transitions in the stochastic systems are governed by <u>probabilities</u> so the the terms $\{n_j\}$ and $\{n_{ij}\}$ in the above equations are really random variables. However, since the equations are linear, the same relationship will hold for the expected values of these variables [6,28], so that

$$\bar{n}_j(T) = \sum_{i=1}^{k} \bar{n}_{ij}(T-1) + \bar{n}_{oj}(T), \qquad \left(j = 1,2,\ldots,k \right) \quad \ldots\ldots(4.4)$$

where $\bar{n}$ denotes the expected or average value of each of the "n"s.

Given the "stock levels" in the different grades at the start, the flows become

$$\left. \begin{array}{l} \bar{n}_{oj}(T) = R(T)\,r_j \\[2em] \bar{n}_{ij}(T-1) = \bar{n}_i(T-1)\,p_{ij} \end{array} \right\} \qquad \left[i,j=1,2,\ldots,k \right] \qquad \ldots\ldots(4.5)$$

Therefore

$$\bar{n}_j(T) = \sum_{i=1}^{k} \bar{n}_i(T-1)p_{ij} + R(T)r_j, \qquad (j = 1,2,\ldots k) \quad \ldots\ldots(4.6)$$

or, using the matrix notation,

$$N(T) = N(T-1)T + R(T)r, \qquad\qquad \ldots\ldots(4.7)$$

where, $N(T)$ is the row matrix of gradewise stock level at time T, $N(T-1)$ is the row matrix of gradewise stock level at time period $(T-1)$, and r is the recruitment vector

This becomes the basic prediction equation, which occupies a prominent place in almost all applications of Markov chain type models.

4.4.2 ESTIMATION OF TRANSITION PROBABILITIES IN MODEL DEVELOPMENT

If the Markov modeling assumptions hold, it is possible to obtain point estimates of the transition probabilities from the historical data by the method of maximum likelihood. However, for this we need complete stock and flow data. If $n_{ij}(T)$ is the observed number of individuals who are in grade i at time (T) and in grade j at time $(T+1)$ and if $n_i(T)$ is the stock (number of individuals present in grade i) at the beginning of this interval T, then the estimate of p_{ij} is given by (see Bhat[7]).

$$\hat{p}_{ij}(T) = n_{ij}(T)/n_i(T), \qquad \left[i, j = 1,2,\ldots,k \right] \quad \ldots \ldots (4.8)$$

If stock and flow data are available over _several_ time intervals for which the transition rates can be assumed to be the same, then

$$\hat{p}_{ij}(T) = \sum_T n_{ij}(T) / \sum_T n_i(T) \qquad \left[i, j = 1,2,\ldots,k \right] \quad \ldots \ldots (4.9)$$

Similarly, the estimate of attrition probabilities $\left\{ a_i \right\}$ may be obtained in an identical manner by using certain "wastage flow" terms in the numerator, while keeping the denominator equal to $\sum_T n_i(T)$.

$$\hat{a}_i(T) = \frac{\sum_T a_i(T)}{\sum_T n_i(T)} \qquad \left[i = 1,2,\ldots,k \right] \qquad \ldots \ldots (4.10)$$

4.4.3 VALIDATION OF THE MODEL.

Admittedly, the danger exits that one would fit Markov models to stock and flow data in a purely mechanical way irrespective of whether or not the underlying assumptions for such a model are satisfied or not. Indeed, if there are gross variations from the required assumptions, any forecasts made with the model are likely to be invalid. Three courses are open to the analyst that separately or in combination can help avoid such a modeling blunder. These are, respectively,

(a)   Conduction of statistical tests of the assumptions,

(b)   Comparison of the predictions of the model with actual outcomes (usually using historical data), for seeking empirical validation, and

(c)   Designing the model, especially with regard to the choice of categories (e.g. grades), so as to make the assumptions, as nearly correct as possible.

The key objectives of fitting a mathematical model to real data (in this context) are (1) to provide improved insights into the dynamics of the system, and subsequently (2) to help make reliable projections. The utility model may be therefore judged by how successfully it delivers the objectives. One very useful way of validating a model is by testing its performance on historical data. If sufficient data are available, one can predict the later part of the series of data using the earlier data. Once the model has been successfully validated, it can be made operational at the user's end.

In the present work, an attempt has been made to design a decision support system which utilizes the Markov type modeling to assist in projecting future population (gradewise) for a given set of input conditions.

DEVELOPING A COMPREHENSIVE HR PLANNING PARADIGM

5.1 THE MANPOWER PLANNING SCENARIO IN A LARGE INDUSTRIAL ORGANIZATION.

We suppose that a large manufacturing organization, employing about 50000 people, is poised for introducing automation on a large scale across all its functional areas to effectively compete in the global market. An immediate impact of the contemplated changes would be surplus/obsolescence issues —both on shop floor as well as in the technical/management grades. This situation might also deteriorate due to influx of fresh qualified recruits to augment the existing expertise mix. Keeping growth and product innovation plans in perspective, top management—wishing to operate a set fixed grade structure for the management cadre—is faced with a number of complex policy choices pertaining to the inflows to managerial population, internal movements, and outflows from the system.

The company has stratified entire managerial population into five grades as M1, M2, M3, M4, and M5. Majority of the new recruits are in M1 grade with almost no hiring into the higher grades. Movement of people from one grade to the immediate higher grade takes place through promotions only. There are no demotions. Also, promotions are limited only into the next immediate grade,

and not beyond. Practice of forcing people to move out of the system rarely. Owing to restrictions in the promotion budget, many people may have to stagnate at a particular grade for longer than a "normal" duration. This in turn demotivates the young high performers. For providing growth into management to shop floor supervisors working below the managerial grades, a screening is conducted every year. In this complex environment, by tradition, manpower planning is being done by applying intuition, experience, and some rules of thumb.

The present study is aimed at such a scenario. It has focused on evaluating useful quantitative paradigms to support the recruitment, promotion, and attrition decisions in the underlying HR planning process. Markov-type formal quantitative models as proposed by Bartholomew [6] are utilized. Clearly, the proposed solution will not predict the precise career path of an individual in the organization. However, it is likely to provide insights into what would happen to a group of employers as a whole as time passes. This eventually could lead to the evaluation and framing of human resource management policy alternatives to enable us to possibly arrive at a preplanned, targeted grade structure and mix—a goal too difficult to attain by the lesser traditional methods.

5.2 THE ARCHITECTURE OF AN HR DECISION SUPPORT MODEL.

The present study is, model-based. Also, it would utilize real life human resource data covering a multiple year span, for calculating estimated transition probabilities of the underlying Markov chain. An assumption inherent in formulating this model is that individuals move independently and with identical "probabilities" that do not vary with time (year to year). The operational diagram of the potential routine use of this model is shown in Figure 5.1.

Manpower, in a particular grade, generally goes through transition with time. After a year, some individuals remain in that grade, some move to the next higher grade, and others flow out through attrition. When the organization gradually becomes old, the actual separations to take place in the near future exceed the historical rate of attritions estimated from the (stationary) transition probability matrix. To reduce this difference, the flows estimated from transition probabilities may be modified with the help of an adjustment vector. We next bring in fresh recruits based on hiring policies adopted by management, the inflow to managerial grades by promotion from supervisory levels, and the forced separations, if any. The outcome of these steps are the projections of gradewise manpower at the different interval periods. Through similar procedures, one may uncover the impact of alternative policies in order to ultimately arrive at a desired graded structure.
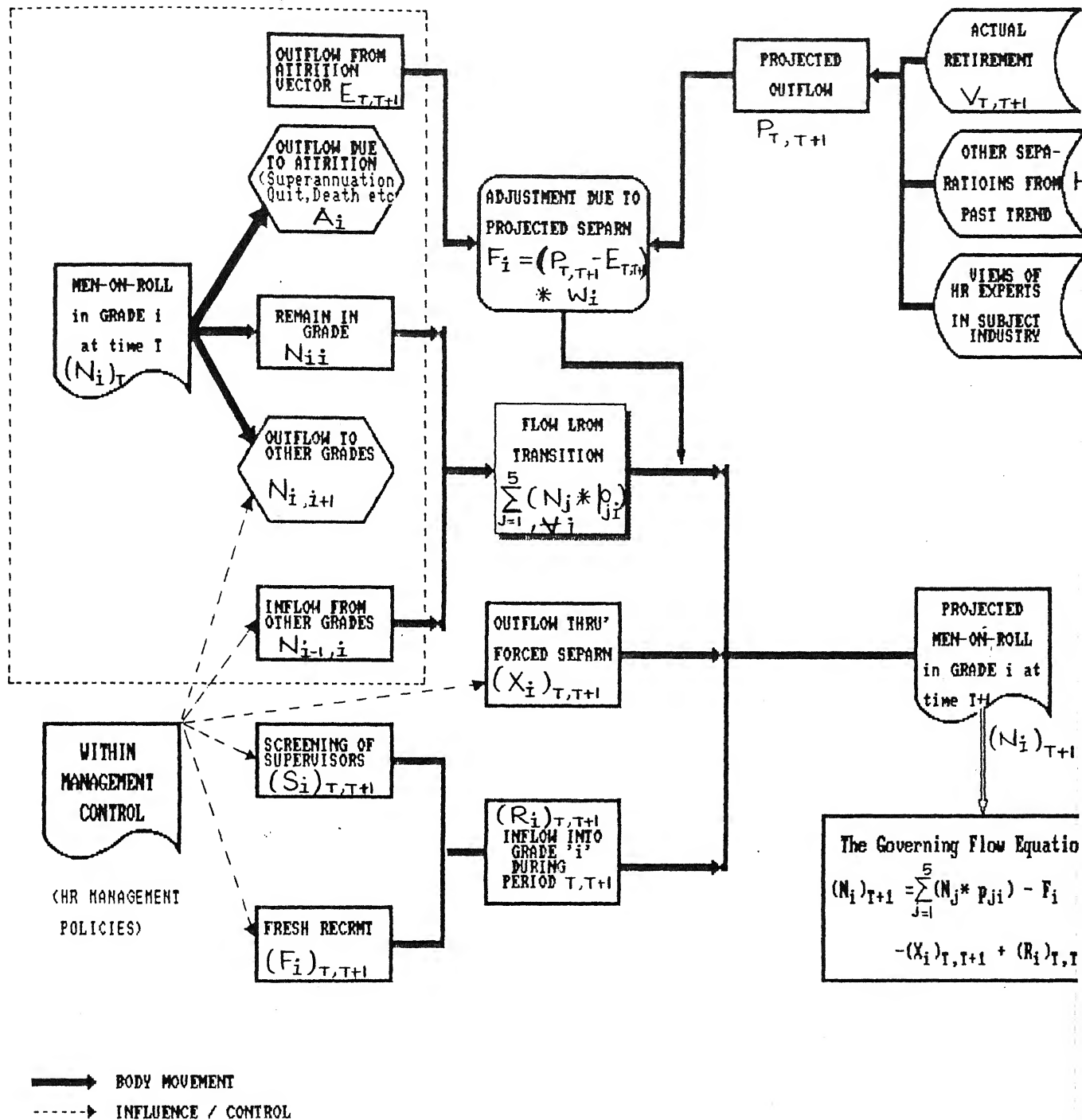
FIGURE 5.1 A REPRESENTATION OF THE MANPOWER   TRANSITION PROCESS

IN A GRADE DURING TIME PERIOD (T, T+1)

Such a planning model may be run on a "spreadsheet" (LOTUS 123 type) environment. The database support may come from another system, for instance a Human resource information system, built using dBASE IV.

5.3 TYPICAL INPUTS NECESSARY TO SET UP THE MANPOWER MODEL.

i) Men_on_roll (say as of April 1) of each year at each grade (say M1, M2, M3, M4 and M5),

ii) Promotion details, grade-wise,

iii) Entries from JO grades (supervisors) to M1 (the first level of management), through screening,

iv) Fresh recruitments from external sources (M.Tech., MBA, Graduate Engineer Trainees etc.). These are direct inflows into managerial grades, v) Earlier years' attrition details in each grade,

vii) Superannuations anticipated in each of next 10 years. vii) Possible management policy alternatives impacting fresh recruitment, screening, promotion and forced separations, and

viii) Yearwise projection of attritions (resignations, deaths, discharge, etc.) other than superannuations for the next 10 years. These data are primarily based on the averages of earlier years' data which have been appropriately modified reflecting the advice of HR experts of the subject industry to help manage the effect of wage revision cycles and future business policy.

5.4 TYPICAL PROCESSES THAT WOULD OCCUR INSIDE THE MODEL.

PROCESS 1:

The model reads raw data on men_on_roll, promotions, attritions, inflows through screening and fresh recruits and then it calculates manpower flows between grades for each year starting from 1983-84 as base year. The data are recorded yearwise as shown in Table 5.1

To grades →	M1	M2	M3	M4	M5	ATTRITION	TOTAL
From grades ↓							
M1	N_{11}	N_{12}	O	O	O	A_1	N_1
M2	O	N_{22}	N_{23}	O	O	A_2	N_2
M3	O	O	N_{33}	N_{34}	O	A_3	N_3
M4	O	O	O	N_{44}	N_{45}	A_4	N_4
M5	O	O	O	O	N_{55}	A_5	N_5
RECRUIT-MENT	R_1	R_2	R_3	R_4	R_5	—	—

Table 5.1 : MANPOWER FLOW BETWEEN GRADES FOR THE YEAR

Here, $N_{11}, N_{22}, N_{33}, N_{44}, N_{55}$ represent number of people who do not leave a particular grade during the year,

$N_{12}, N_{23}, N_{34}, N_{45}$ the represent promotions from one grade to the next higher grade,

$A_1 \ldots A_5$ represent number of employees separated from each grade through superannuation, resignation, death, discharge etc.,

$N_1 \ldots N_5$ are summations of all column entries in each grade respectively. Therefore, they represent grade_men_on_roll at the beginning of the year and are given by,

$$N_i = \sum_{j=1}^{5} N_{i,j} + A_i, \quad \text{For any grade } i, \qquad \ldots \ldots \ldots \ldots \ldots (5.1)$$

Where $N_{i,j}$ is the body flow from grade "i" to grade "j" and A_i is the flow to attrition from grade "i" during the year,

$R_1 \ldots R_5$ are total inflow to each grades through recruitment and also through screening during the year. Hence, in a generalized term,

$$R_i = S_i + F_i, \qquad \ldots \ldots \ldots \ldots \ldots (5.2)$$

where, R_i is total inflow to grade i during a year, S_i is number of employees (supervisors) entering into grade i through screening in a year, and F_i is number of fresh recruits to grade i during above period.

Since, there in no accelerated jumps at a time during promotion of an employee and also no demotions existing in the subject industry, other entries in table (5.1) are zeros.

PROCESS 2:

Estimation of parameters of the transition probability matrix with the help of between_grade movement data from earlier years. This uses the principle of Maximum Likelihood Estimates [7] as explained in chapter 4. By using the equation (4.9), the estimated Transition Probability from grade i to grade j is given by

$$\hat{P}_{i,j} = \frac{\sum\limits_{T=1}^{8} N_{i,j}}{\sum\limits_{T=1}^{8} N_{i}} \quad ; \quad i,j = 1....5 \qquad \ldots\ldots\ldots\ldots (5.3)$$

where,

$N_{i,j}$ = Flow from grade i to grade j during year T,

N_i = Men-on-roll in grade i at the beginning of the year,

i,j = 1,2...5 grades (there are only 5 grades in the subject industry and T is the time horizon for collecting earlier data.

$$A = \begin{bmatrix} \hat{a}_1 \\ \hat{a}_2 \\ \hat{a}_3 \\ \hat{a}_4 \\ \hat{a}_5 \end{bmatrix}$$

where,

$$\hat{a}_i = \frac{\sum_{T=1}^{8} (A_i)}{\sum_{T=1}^{8} (N_i)}, \qquad i = 1 \ldots \ldots 5, \qquad \ldots \ldots (5.4)$$

and A_i = Number of employees separated from grade "i" in a year.

Similarly, by using above principle, one obtains the inflow vector R as:

$$R = [\hat{r}_1, \hat{r}_2, \hat{r}_3, \hat{r}_4, \hat{r}_5],$$

where,

$$r_i = \frac{\sum\limits_{T=1}^{8}(R_i)_T}{\sum\limits_{T=1}^{8}\left(\sum\limits_{i=1}^{5}R_i\right)_T}, \qquad \dots\dots\dots(5.5)$$

R_i is total inflow to grade i during the year as explained in step 2 above.

PROCESS 4:

Calculation of the projected population by grade, based on the base year's (say 1991) grade population. This uses the row vector M of men_on_roll; and Transition probability Matrix T in the following manner:

Let M_T be the row vector of men-on-roll i.e. $[N_1, N_2, N_3, N_4, N_5]$ at the base year T.

Then, with the help of equation (4.7) of chapter 4, the expected men_on_roll after a year due to transition (without considering inflow at this stage) is

$$M_{T+1} = M_T * T^t \qquad \dots\dots\dots\dots(5.6)$$

PROCESS 5:

The Model then calculates the expected <u>total separations</u> E (after one year) from the attrition column vector A and the base men-on-roll, M_T.

$$E = M_T * A \qquad \ldots\ldots\ldots\ldots (5.7)$$

PROCESS 6:

From the anticipated separation data (superannuations) for next 9 years and year-wise projection of other separations (resignations, deaths, discharge, etc.) reflecting advice of HR experts of the subject industry, the model next generates the <u>gradewise wastage vector</u> W for future years, in the following manner:

$$W = [\hat{w}_1, \hat{w}_2, \hat{w}_3, \hat{w}_4, \hat{w}_5]$$

where,

$$\hat{w}_i = \frac{\sum_{T=1}^{9} (V_i)_T}{\sum_{T=1}^{9} (\sum_{i=1}^{5} V_i)_T}, \qquad i = 1 \ldots 5, \qquad \ldots\ldots\ldots (5.8)$$

and $(V_i)_T$ = Anticipated retirements in grade i duringt time period T.

Since retirement data is assured to be available for the next 9 years, we have considered T to vary from 1..9.

PROCESS 7:

To reduce the impact of the difference between the anticipated
future separations P and the expected outflow E through attrition
vector on the grade-wise future manpower, adjustment of the
expected men on roll due to transition M^t is done. This is done
with the help of an adjustment vector F as follows:

$$F = (P - E) * W, \quad \dots\dots\dots\dots(5.9)$$

where, P is anticipated future separations, or the sum of
anticipated retirement V and anticipated other separations H based
on the averages of earlier years' separations data appropriately
modified reflecting judgment of HR experts familiar with the the
subject industry i.e. $P = V + H$

PROCESS 8:

As the final step in the process, grade-wise manpower projection
M_{T+1} for the following year is developed in the following manner
by using equation 5.6 and 5.9.

$$M_{T+1} = M_{T+1}^{t} - F_{T,T+1} + R_{T,T+1} - X_{T,T+1} \qquad \ldots\ldots\ldots\ldots (5.11)$$

$M_{T+1} =$ ((Expected men_on_roll M_{T+1}^{t} after a year due to transition) − (Adjustment vector $F_{T,T+1}$ during this period) + (Management policy decisions on inflow (through fresh recruits and screening) $R_{T,T+1}$) − (forced outflow $X_{T,T+1}$ during the above period)).

With the help of the above manpower equation, grade-wise population for the future years may be calculated by repeating the process for each following year.

5.5 OUTPUTS RESULTING FROM THE MODEL.

A prototype of this model was developed that runs on the LOTUS 123 spreadsheet. This produces the following two key outputs:

i) The summary of yearwise management policy alternative, input by management, on recruitment, screening of supervisors and forced separations.

ii) The graphical and numerical display of gradewise manpower for future years.

5.6 VALIDATION OF THE MANPOWER DECISION SUPPORT MODEL.

Any decision support model, with appropriate input, is expected to assist in (1) the study of the dynamics of the system and (2) decision making and the development of projections with high dependability. Therefore any DSS model proposed must be validated in order to achieve these objectives.

Actual prior year manpower data on gradewise men_on_roll were employed to validate the model described above. Specifically

i) Grade-wise men_on_roll as of 1.4.83 from a subject organization was taken as the base manpower.

ii) The Manpower flow equation (5.11), as stated earlier, was used to determine gradewise manpower projections for each following year.

iii) The Grade-wise projected men_on_roll was then compared with the actual population on record of the applicable year.

The difference between actual and the projected on_roll was found to be within an acceptable limit (ref. Appendix, pp 126). This, reflecting on the quality of the inputs, provide sufficient support for the proposed model to be adopted to help the subject industry in determining its future manpower for different grades. Normally HR management groups would be expected to use this model while deciding on various HR policies (how many to hire,

what skills, whether to force attrition, etc.).

Literature available in manpower planning models suggests that earlier researchers have had the tendency to keep the impact of future management policy alternatives beyond the domain of Markov type models. The present work, deliberately make provisions to enable management evaluate the potential impact of various policy dependent parameters and factors influencing inflows and outflows. To minimize forecasting errors, the present model conditions Markov-projected attrition data with actual anticipated separation in each grades. This yields the adjusted forecast manpower on yearly basis. Later this could be improved when an HRIS is fully functional and is able to show projected separations by individual grade.

5.7 DETAILS OF BUILDING AN HRIS.

The HR model to be operational, certain data must be provided as an input to the model. It is imperative that a database be created with an effective methodology, so that, the projections and policy evaluation studies would lead to meaningful returns in real world. In the present case, A Human Resource Information System (HRIS) was built on the principle of "staged database approach" [30]. The staged database approach is a top-down method that begins with general statements of the organization's needs and progresses to more and more detailed consideration of these needs till the system is successfully implemented at user's

premises.   This method is flexible enough to allow changes as and
when new information needs arise.

5.7.1 USER NEED SURVEY.

The first and clearly the most important step in data support to
an HRIS model would be to determine the data organization
requirements of the different users of the enterprise.   The
assessment of these needs is generally done by conducting a series
of   interviews,   formal/informal,   within   the   various   user
departments [30,24].   A questionnaire survey-type approach may be
utilized.   The present work followed the steps shown below.

STEP 1: IDENTIFICATION OF DATA OBJECTS OR ENTITIES

An   interview-based need survey methodology was used to list out
the   data   entities   of   interest   to   the   users   in   the   subject
industry.   The following questions were asked to the user group:

i)   What are the objects (entities) of interest to you?

ii)   What is the appropriate name to each entities?

iii) What facts (attributes) about each specified   entity   are   of
     interest to you?

iv)   What is the most appropriate name for each attribute?

v)   What is the domain of values for each of these attributes?

vi) What are the known dependencies between the attributes of each entity?

vii) Are there any unique identifiers for the different entities ?

The result of this interview would be a list of well-defined entities and their attributes. After suitably merging of the list, the aggregate list was given to all users for their approval. The Entities and the attributes enumerated for the subject industry were as follows:

ENTITY	ATTRIBUTES
Employee	Ticket No., Department, Classification, Name, Grade, Designation, Date of Birth, Date of Appointment, Basic Qualification, Professional Qualification, Training Qualification.
Client Department	Department Code, Description, Division Code.
Management Development Division	Department Code, Division Code.

STEP 2: IDENTIFICATION OF THE RELATIONSHIPS

Relationships between entities were identified by asking the following questions to the HR experts in the organization and other potential users of the database.

i)   What are the known relationships (correspondences) between entities?

ii) What is the appropriate name(s) for each such relationship?

iii) What is the "mapping property" [30] of each relationship —1:1, 1:N, and N:M?

iv) Is the relationship expressible in closed form [30] using the attributes of the entities?

v)   What are the possible relationships which are not explicitly used, but may be still meaningful?

STEP 3:

From the list of entities and relationship between them, an enterprise description was produced. The result was summarized as the help of an E-R diagram, that expresses the logical properties of the database in an enterprise schema. For the present HRIS, the final E-R diagram [30] is shown in Figure 5.2.
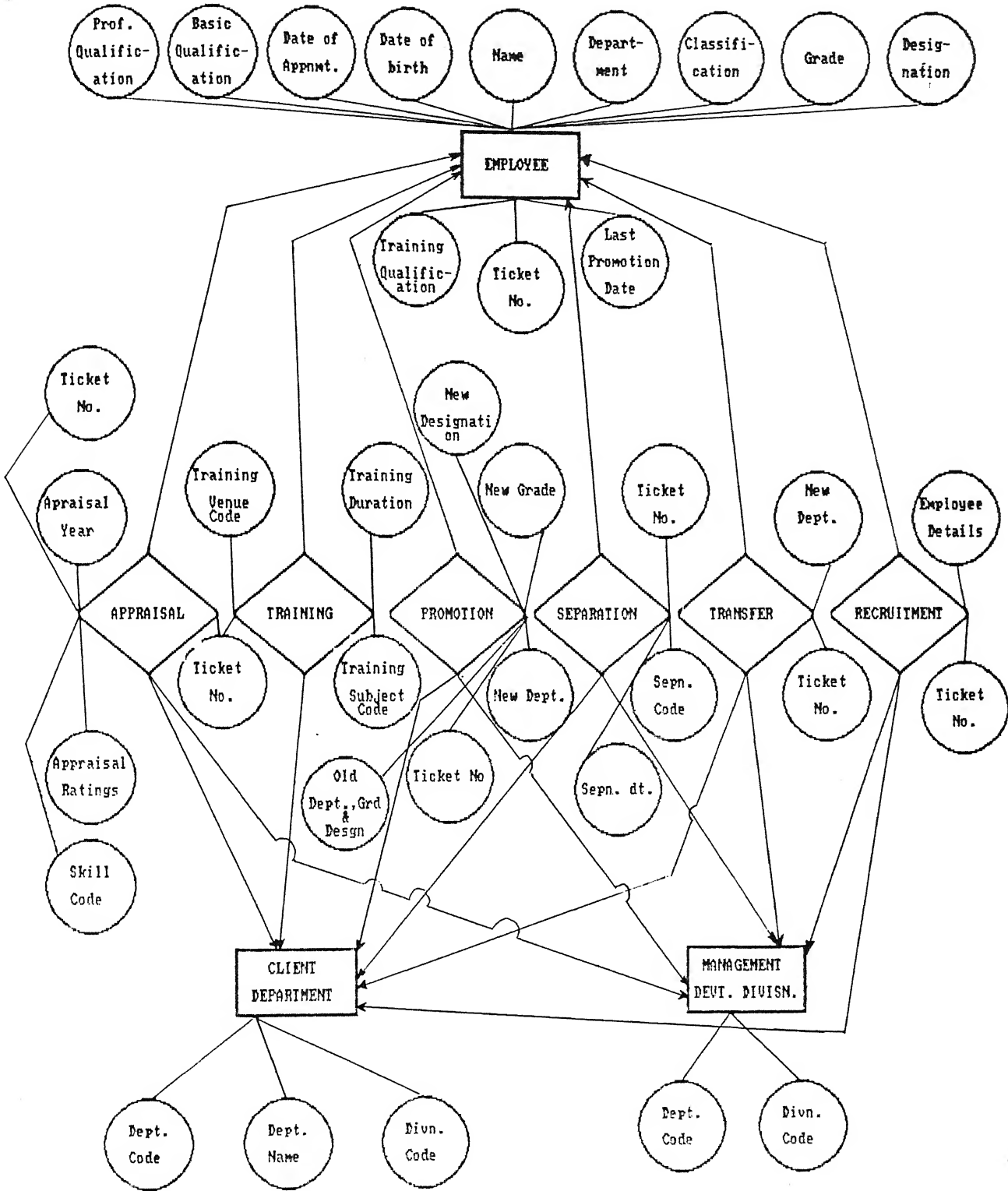
Figure 5.2 E-R Diagram of HRIS

ENTITIES
ATTRIBUTES
RELATIONS
PROCESS

STEP 4: IDENTIFICATION OF THE USES OF THE INFORMATION SYSTEM BEING DESIGNED.

The next step of our need survey was to determine the types of information transactions, current and projected, required or anticipated by the enterprise. A transaction in this context is an action, or set of actions that requires access to the data stored in the database. For example, report generation, entry of new employer, a transfer or promotion etc. are transactions.

Some relevant questions asked to the users, at this stage, were,

i) What transactions are required by you?

ii) What kind of access is required by each of these transaction — retrieval, update, etc.?

iii) What is the anticipated frequency of each such transaction — daily, weekly, monthly?

iv) What entities, attributes, and relationships are involved in each transaction?

v) What is the processing priority of each transaction?

vi) What reports are needed by you? By management? By others ?

vii) What is the suggested format for each such report?

vii) What is the acceptable time-frame for producing each report?

viii) What security requirements are important?

ix) What integrity constraints are to be placed on the data?

The result of this exercise was a list of transactions and their characteristics, and current as well as anticipated future needs the decision support system should meet. These identified transactions, database entities and all needed relationships, are given in Table 5.2.

Transaction Details	Entities	Relationship
Promotion of an employee	employee, department. Management Development Division (MD).	Employee-promotion processing.
Transfer of an employee	employee, department, MD.	Implement Employee-Transfer
Recruitment	employee, MD.	Monitor Employee-Inflow
Separation	employee, MD.	Manage Employee-Separation
Appraisal of an employee	employee, department, and MD.	Maintain Employee appraisal
Training	Employee, MD	Tracking Employee-training
Qualification Upgradation	Employee, MD	Updating Employee-qualification

Table 5.2 : Transactions observed through need survey

5.7.2 THE DESIGN OF THE HRIS DATABASE.

After it has been determined where data originates, where it is captured, where it is processed, and where it is directed after processing, an information system designer starts by constructing Data flow Diagrams (DFDs) [30]. These diagrams show the flow of data through the enterprise. They provide the useful "model" for communicating with users, other designers, and managers, about the features of the existing information system and the proposed system. The DFD for the present work is given in Figure 5.3.

From the DFD, the data-base structure is designed by using the principle of Relations, which is physically best represented as a table. These tables are use to hold information about the objects to be represented in the database. A "relation" (in the language of relational database systems) is as a two-dimensional table that corresponds to individual records. The columns in a relation corresponds to attributes. For example, the Employee "relation" is represented by the table 5.3 as given below.

Employee

Ticket_no	Emp_name	Emp_grade	Birth_date.
17106	Peter Smith	M3	14.11 59
17107	Rex Periera	M4	11 01 62
17108	R. Krishnan	M5	23 o9 65

Table 5.3
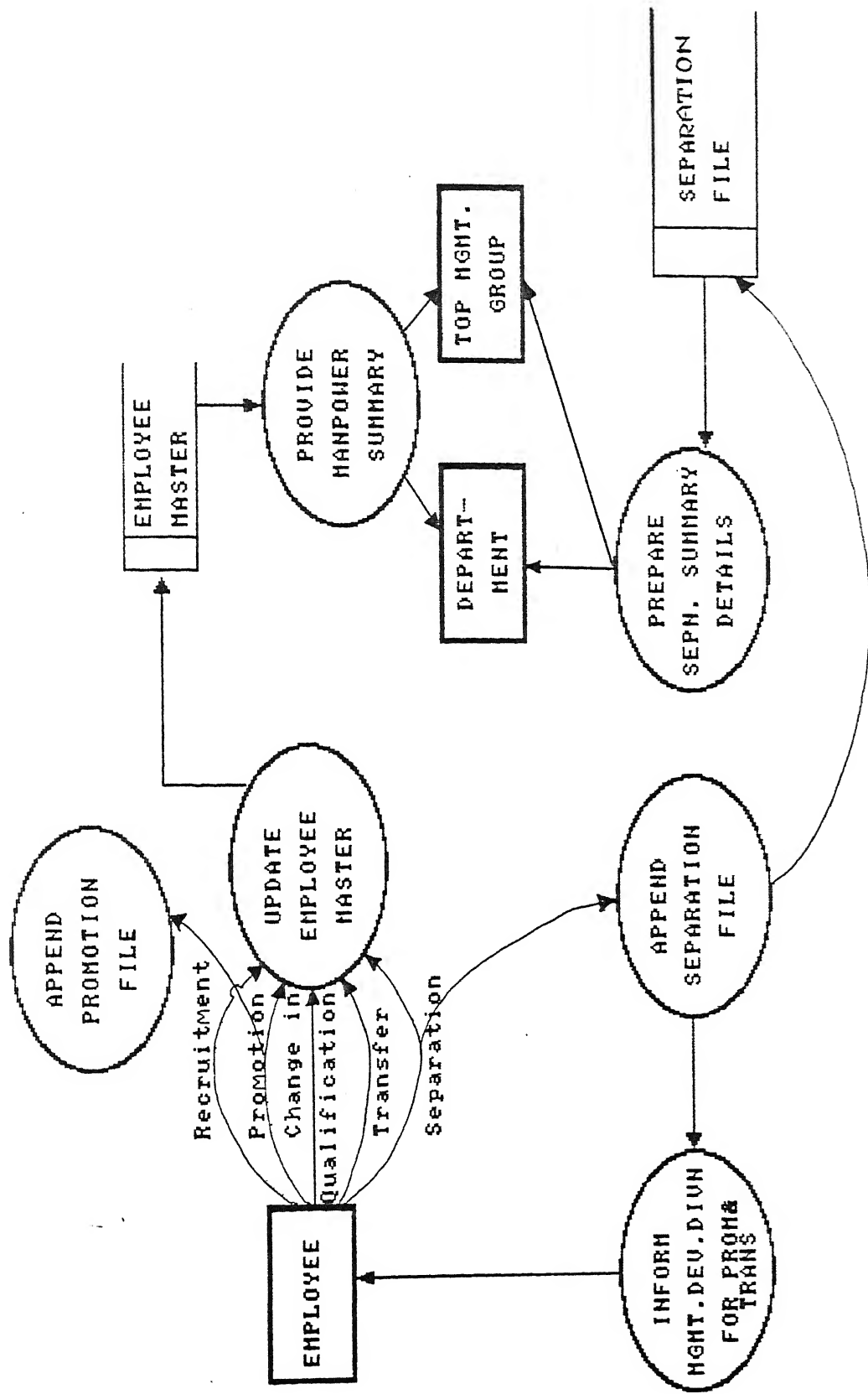
Figure 5.3 DATA FLOW DIAGRAM FOR HUMAN RESOURCE INFORMATION SYSTEM

As we see from this example, a column contains the different valid values of a single attribute. Each row in the above relation is known as a tuple. In this case, the super key is "Ticket_no. This attribute helps in identifying the tuples uniquely.

Integrity constraints also have been taken into consideration at this stage. For instances, no attribute of a primary key can be allowed to have a null value.

Lastly, the database is normalized in third normal form [20] to take care of transitive dependencies, provided no multivalued dependencies are present. This helps achieving a database design that is devoid of redundancies and anomalies and yet flexible, allowing addition of new attributes.

The present HRIS integrated employee source database file, training details, and appraisal records of all employees. This in itself was a new major benefit for the subject enterprise. One could now perform the following operations using the comprehensive database:

A) **Employee Records Management.**

i) Facilitates in adding a new record in the employee source database at the time of inflows to managerial grades.

ii) Facilitates in changing (Update) the data in a record due to promotions, transfers, qualification upgradation, and separations.

iii) Helps in finding the details of an employee, summary of manpower, department wise men_on_roll status for various grades, and total manpower summary of the enterprise.

B) Training Information Management.

i) Update training records of an employee,

ii) Add new programs into the database,

iii) Facilitate query on past training details of an employee and also list the people who have attended a particular training programme or the institutions offering such programs.

C) Appraisals Information Management.

i) Update appraisal records of employees,
ii) Do query on employee traits, skills, and appraisal summary.

The system also offers provisions for indexing, printing, restoring and backing up files.

5.7.3   QUERY SUPPORT.

Keeping the subject enterprise in mind,   attempts were made to make the HRIS user friendly, utilizing pull-down menus and help messages wherever appropriate.   As   required, inbuilt validity   checks for data input were incorporated. This would ensure correct and reliable data support to the HR decision model.

Reflecting the needs brought out by the initial surveys, the following query supports were incorporated in this information system.

i)   Gradewise men_on_roll for various departments,   divisions, and enterprise as a whole.

ii)   Profile of individual employees(on   request)   to   show years_of_service,   duration_of_stay   in   a   grade,   age, qualifications,   skills,   performance on the   job,   training given and areas handled,   etc.

iii) Yearwise future superannuations projected,   by grade.

iv)   Past   separations   details — highlighting   specifically   the reasons of separations.

v)   Gradewise promotion details for past years.

The codes for HRIS was written in the dBASE-IV language and tested before the implementation. This information system, in addition to supporting queries, would provide necessary data input to the HR DSS [section 5.1, process 1]. It is also expected that the system would eventually eliminate the manually maintained personnel records and provide quicker data retrieval to facilitate effective HR management decisions.

The program logic, database file structure, and a typical user session with the HRIS are given in the Appendix.

THE IMPLEMENTATION OF THE PROPOSED MODEL-BASED
HR PLANNING APPROACH

6.1 ESTIMATION OF MODEL PARAMETERS USING EARLIER YEARS' DATA.

To accomplish a prototype implementation of the model, raw data (spanning nine prior years) were collected from a real industry and compiled in tables as shown below. A "year" here implies the period from 1st April to 31st March.

(i) Gradewise men-on-roll:

This number is the count of individuals employed in management grades M1 to M5 respectively, at the beginning of the "year".

MEN_ON_ROLL AS OF	M1	M2	M3	M4	M5	MTOTAL
01.04.83	617	721	430	210	171	2149
01.04.84	575	751	472	225	190	2213
01.04.85	584	757	482	232	193	2248
01.04.86	519	746	533	208	217	2223
01.04.87	511	707	558	228	212	2216
01.04.88	474	654	583	246	218	2175
01.04.89	453	582	589	252	224	2100
01.04.90	386	583	576	257	224	2026
01.04.91	338	607	588	265	231	2029

Table 6.1.1

(ii) Promotions from one grade to the next:

| YEAR | Promotion From....To | | | |
	M1 → M2	M2 → M3	M3 → M4	M4 → M5
1983-84	96	79	29	28
1984-85	96	76	45	30
1985-86	139	134	43	46
1986-87	65	77	49	17
1987-88	65	90	47	31
1988-89	64	88	55	36
1989-90	99	68	40	23
1990-91	106	81	54	31

Table 6.1.2

(iii) The inflows to each grade—these includes fresh recruitments
and the screening of non-managerial supervisors into M1 grade:

| YEAR | PROMOTIONS into M1 through SCREENING | FRESH RECRUITMENT | | | | |
		M1	M2	M3	M4	M5
1983-84	55	19	15	0	1	0
1984-85	59	68	20	0	0	3
1985-86	53	31	23	4	3	0
1986-87	45	27	2	0	0	3
1987-88	12	40	6	1	2	0
1988-89	17	53	10	1	1	2
1989-90	20	30	17	3	0	0
1990-91	31	33	17	0	0	1

Table 6.1.3

(iv) Separations on record by grades (Total Attrition):

YEAR	M1	M2	M3	M4	M5
1983-84	20	33	22	5	16
1984-85	28	31	13	7	21
1985-86	20	31	26	15	24
1986-87	10	27	16	16	27
1987-88	21	27	23	5	17
1988-89	19	34	21	5	24
1989-90	25	39	24	8	20
1990-91	27	23	26	19	26

Table 6.1.4

(v) Yearly separations broken into components (available for the immediate five prior years):

Year	Superannuations	Others (Death, discharge, resignation, etc.)	Total separation
1986-87	36	60	96
1987-88	46	47	93
1988-89	57	46	103
1989-90	65	49	114
1990-91	60	61	121

Table 6.1.5

(vi) Superannuations anticipated in each grade for next nine years (based on the dates of birth of the men-on-roll):

YEAR	M1	M2	M3	M4	M5	MTOTAL
1992-93	6	14	16	6	5	47
1993-94	29	31	17	11	11	99
1994-95	24	42	14	6	13	99
1995-96	17	33	23	8	13	94
1996-97	29	40	18	11	9	107
1997-98	30	29	29	6	9	103
1998-99	22	32	35	9	10	108
1999-2000	26	37	30	13	16	122

Table 6.1.6

(Vii) Yearwise projection of other separations (resignations, death, discharge etc.). These numbers reflect the judgments and conjectures of senior HR management of the subject industry.

YEAR	TOTAL PROJECTED "OTHER" SEPARATIONS, IN ALL GRADES COMBINED.
1991-92	79
1992-93	79
1993-94	79
1994-95	79
1995-96	79
1996-97	70
1997-98	70
1998-99	70
1999-2000	70

Table 6.1.7

6.2 SUMMARY OF MANPOWER MOVEMENTS YEARWISE.

Based on the shown above data, manpower flow from one grade to another could be calculated. The details are as follows,

i) Manpower Movement during 1983-84.

	To	M1	M2	M3	M4	M5	AT (Attrition)	TOTAL
From	M1	575	96	0	0	0	20	691
	M2	0	751	79	0	0	33	863
	M3	0	0	472	29	0	22	523
	M4	0	0	0	225	28	5	258
	M5	0	0	0	0	190	16	206
	AT	0	0	0	0	0	96	96

Table 6.2.1

ii) Manpower Movement during 1984-85.

	To	M1	M2	M3	M4	M5	AT (Attrition)	TOTAL
From	M1	584	96	0	0	0	28	708
	M2	0	757	76	0	0	31	864
	M3	0	0	482	45	0	13	540
	M4	0	0	0	232	30	7	269
	M5	0	0	0	0	193	21	214
	AT	0	0	0	0	0	100	100

Table 6.2.2

iii) Manpower Movement during 1985-86.

	To	M1	M2	M3	M4	M5	AT	TOTAL
From	M1	519	139	0	0	0	20	678
	M2	0	746	134	0	0	31	911
	M3	0	0	533	43	0	26	602
	M4	0	0	0	208	46	15	269
	M5	0	0	0	0	217	24	241
	AT	0	0	0	0	0	116	116

Table 6.2.3

iv) Manpower Movement during 1986-87

	To	M1	M2	M3	M4	M5	AT	TOTAL
From	M1	511	65	0	0	0	10	586
	M2	0	707	77	0	0	27	811
	M3	0	0	558	49	0	16	623
	M4	0	0	0	228	17	16	261
	M5	0	0	0	0	212	27	239
	AT	0	0	0	0	0	96	96

Table 6.2.4

v) Manpower Movement during 1987-88

	To	M1	M2	M3	M4	M5	AT	TOTAL
From	M1	474	65	O	O	O	21	560
	M2	O	654	90	O	O	27	771
	M3	O	O	583	47	O	23	653
	M4	O	O	O	246	31	5	282
	M5	O	O	O	O	218	17	235
	AT	O	O	O	O	O	93	93

Table 6.2.5

vi) Manpower Movement during 1988-89.

	To	M1	M2	M3	M4	M5	AT	TOTAL
From	M1	453	64	O	O	O	19	536
	M2	O	582	88	O	O	34	704
	M3	O	O	589	55	O	21	665
	M4	O	O	O	252	36	5	293
	M5	O	O	O	O	224	24	248
	AT	O	O	O	O	O	103	103

Table 6.2.6

vii) Manpower Movement during 1989-90.

	To	M1	M2	M3	M4	M5	AT	TOTAL
From	M1	386	99	0	0	0	25	510
	M2	0	583	68	0	0	39	690
	M3	0	0	576	40	0	24	640
	M4	0	0	0	257	23	6	286
	M5	0	0	0	0	224	20	244
	AT	0	0	0	0	0	114	114

Table 6.2.7

viii) Manpower movement during 1990-91.

	To	M1	M2	M3	M4	M5	AT	TOTAL
From	M1	338	106	0	0	0	27	471
	M2	0	607	81	0	0	23	711
	M3	0	0	588	54	0	26	668
	M4	0	0	0	265	31	19	315
	M5	0	0	0	0	231	26	257
	AT	0	0	0	0	0	121	121

Table 6.2.8

6.3 ESTIMATION OF TRANSITION (MOVEMENT) PROBABILITIES.

Based on the above movement data, the transition probabilities incorporating attrition vector A could be estimated, as follows.

	To	M1	M2	M3	M4	M5	A
From	M1	0.810	0.154	0.000	0.000	0.000	0.036
	M2	0.000	0.852	0.110	0.000	0.000	0.038
	M3	0.000	0.000	0.892	0.074	0.000	0.034
	M4	0.000	0.000	0.000	0.857	0.108	0.035
	m5	0.000	0.000	0.000	0.000	0.907	0.093
	A	0.000	0.000	0.000	0.000	0.000	1.000

Table 6.3

6.4 USING THE MODEL TO PROJECT FUTURE MANPOWER REQUIREMENTS.

The following scenario is envisaged in the routine (once a year) use of the manpower planning model. First, the base men-on-roll data (by grades) would be compiled. Policy alternatives to be evaluated in terms of hiring, separation, and target population goals for the following (future year) would be requested from management. The model would then produce projections of the future manpower population, gradewise, presenting the data in tabular and graphical format.

The following pages display the information typically generated showing this various probable future scenarios for an industry. Realistic management inputs from the subject industry were utilized in producing these scenarios. The objective here was to evaluate how effectively this model runs, and projects the potential impact of the different "policies" on the population by grade of the management personnel.

The men-on-roll as of 1.4.91 was taken as the baseyear manpower population. These were M1=338, M2=607, M3=588, M4=265, and M5=231 respectively.

The following four policy alternatives were put to "test" to evaluate their long term impact on the organization.

a) The number of supervisors promoted to the M1 grade through screening,

b) Number of fresh hirings through external recruitment,

c) Forced separations to be caused in these grades by offering a "golden-handshake", and

d) Regulating the no. of promotions into each managerial grade.

The specific numerical choices considered for the four above policy parameters are shown in table 6.4.1.

As shown in this table, nine distinct policy alternatives were evaluated using the model. The outputs produced, i.e., the yearwise manpower numbers projected for each policy alternative

are shown in Figures 6.4.2-8.

Alternative policies (numerically stated):

POLICY	INFLOW through SCREENING into M1 GRADE p.a.	FRESH RECRUITMENTS p.a.	FORCED SEPARATIONS p.a.	AVERAGE % PROMOTION RATE p.a.
ALT-1	40	M1=30, M2=10	NIL	AS EXISTING (M1=15.4, M2=11.0, M3=7.4, M4=10.8)
ALT-2	NIL	M1=40, M2=10	NIL	-DO-
ALT-3	40	M1=45, M2=15	M1=5, M2=3, M3=3, M4=2, M5=2.	-DO-

POLICY	INFLOW through SCREENING into M1 GRADE p.a.	FRESH RECRUITMENTS p.a.	FORCED SEPARATIONS p.a.	AVERAGE % PROMOTION RATE
ALT-4	40	M1=30 M2=10	M1=3, M2=2 M3=2, M4=2 M5=1	AS EXISTING (M1=15.4, M2=11.0, M3=7.4, M4=10.8)
ALT-5	45	M1=40 M2=15	M1=6, M2=6 M3=3, M4=3	M1=15, M2=15 M3=10, M4=10
ALT-6	25	M1=25 M2=10	NIL	-DO-
ALT-7	40	NIL	NIL	AS EXISTING (M1=15.4, M2=11.0, M3=7.4, M4=10.8)
ALT-8	NIL	NIL	NIL	-DO-

Table 6.4.1: MANAGEMENT POLICY ALTERNATIVES.

By design, it would be possible to develop forecasts of the manpower for the future years with the help of the decision support model. Depending on the business environment,then, management could evaluate a number of possible alternatives. The specific outputs, consequent to the alternatives listed in Table 6.4.1 , turned out as follows.

a) Policy ALT-1:

HR MANAGEMENT POLICY:

—Inflow through screening into M1 grade=40 supervisors p.a.
—Fresh recruits into M1 and M2 grades are 30, and 10 p.a. respectively.
—No forced separations, and continuing with the existing promotion rate.

MODEL'S PROJECTION:

DATE	M1	M2	M3	M4	M5	MTOTAL
1.4.91	338	607	588	265	231	2029
1.4.92	338	571	586	268	235	1999
1.4.93	335	536	576	270	238	1954
1.4.94	319	487	550	265	235	1856
1.4.95	306	442	521	259	231	1759
1.4.96	296	402	491	251	227	1667
1.4.97	285	364	458	242	221	1571
1.4.98	277	330	424	232	215	1478
1.4.99	268	297	388	220	208	1381
1.4.2000	257	262	348	205	198	1269

Table 6.4.2: Manpower Forecast upto 2000 A.D.
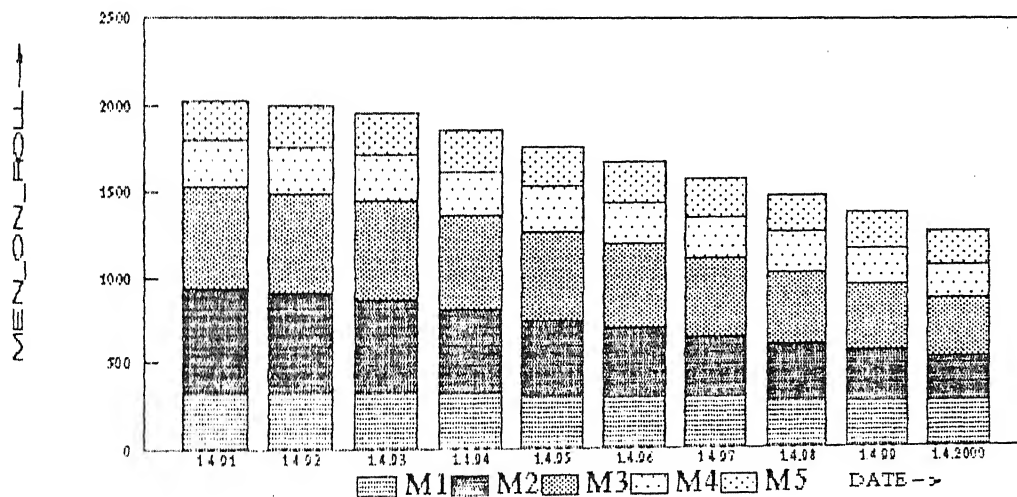
Fig. 6.4.2: Gradewise Manpower Scenario Upto 2000 A.D.

— Sharp decline in M2 and M3 grade population
—M4 grade manpower will initially increase and then it will gradually come down

a) Policy ALT-2:

HR MANAGEMENT POLICY:

—No Inflow through screening into M1 grade.
—Fresh recruits into M1 and M2 grades are 40, and 10 individuals p.a. respectively.
—No forced separations, and continuing with the existing promotion rate.

MODEL'S PROJECTION:

DATE	M1	M2	M3	M4	M5	MTOTAL
1.4.91	338	607	588	265	231	2029
1.4.92	308	571	586	268	235	1969
1.4.93	280	531	575	270	238	1894
1.4.94	245	474	549	265	234	1766
1.4.95	215	418	518	258	230	1639
1.4.96	191	366	484	250	225	1517
1.4.97	169	316	446	240	219	1390
1.4.98	151	269	407	229	213	1268
1.4.99	135	223	364	215	204	1141
1.4.2000	117	175	316	198	193	999

Table 6.4.3: Manpower Forecast upto 2000 A.D.
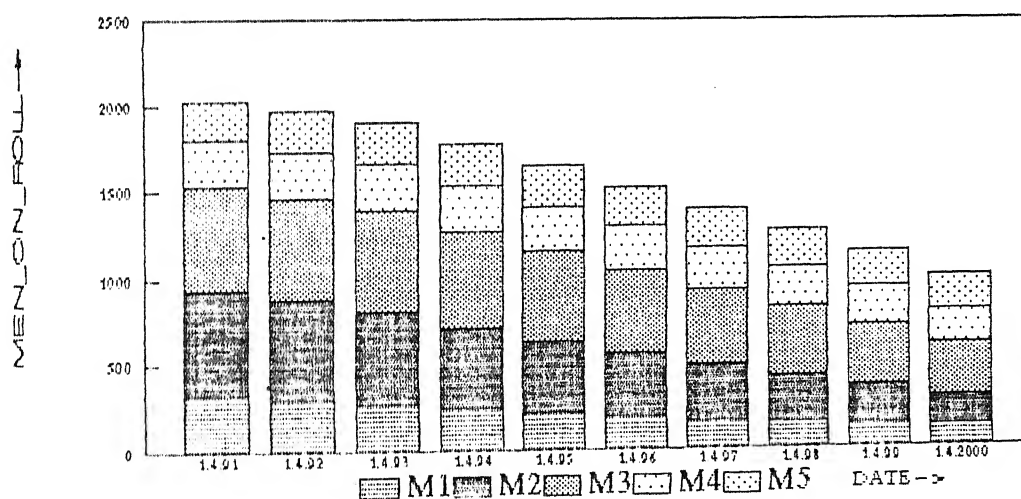
Fig. 6.4.3: Gradewise Manpower Scenario Upto 2000 A.D.

—Sharp decline in M1, M2 and M3 grade population.

a) Policy ALT-3:

HR MANAGEMENT POLICY:

—Inflow through screening into M1 grade =40 individuals p.a.
—Fresh recruits into M1 and M2 grades are 45 and 15 individuals p.a. respectively
—Forced separations are M1=5, M2=3, M3=3, M4=2, M5=2 individuals p.a.
and continuing with the existing Promotion rate.

MODEL'S PROJECTION:

DATE	M1	M2	M3	M4	M5	MTOTAL
1.4.91	338	607	588	265	231	2029
1.4.92	348	573	583	266	233	2004
1.4.93	353	541	570	266	234	1964
1.4.94	344	497	543	259	229	1871
1.4.95	336	456	513	251	223	1779
1.4.96	330	421	482	242	216	1692
1.4.97	323	387	449	232	209	1601
1.4.98	318	358	415	220	201	1513
1.4.99	312	329	380	207	192	1421
1.4.2000	302	298	342	192	180	1314

Table 6.4..4: Manpower Forecast upto 2000 A.D.
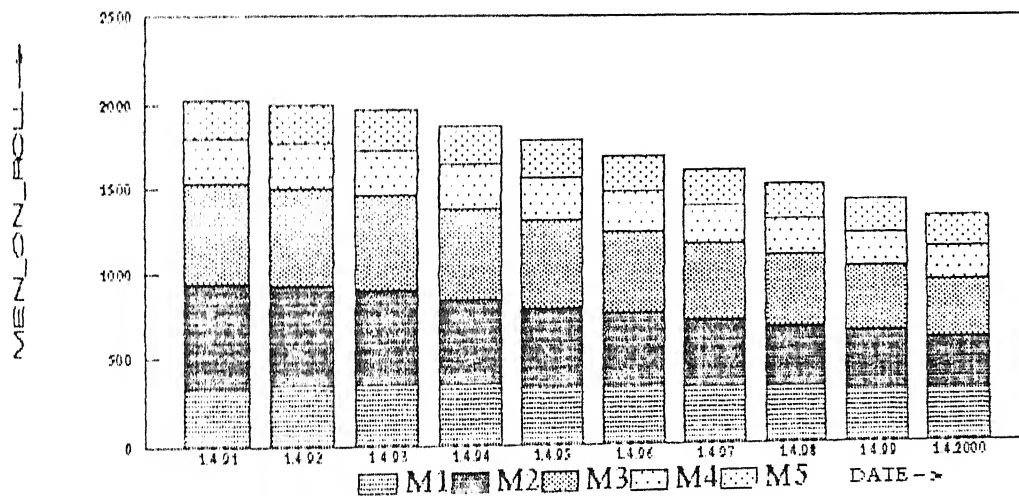
Fig. 6.4.4: Gradewise Manpower Scenario Upto 2000 A.D.

—Fast depletion of M2 and M3 grade population

a) Policy AL 1−4:

HR MANAGEMENT POLICY:

—Inflow through screening into M1 grade =40 individuals p.a.
—Fresh recruits into M1 and M2 grades are 30 and 10 individuals p.a respectively
—Forced separations are M1=3, M2=2, M3=2, M4=2, M5=1 individuals p.a. and
continuing with the existing Promotion rate.

MODEL'S PROJECTION:

DATE	M1	M2	M3	M4	M5	MTOTAL
1.4.91	338	607	588	265	231	2029
1.4.92	337	543	592	284	232	1988
1.4.93	332	486	582	299	234	1931
1.4.94	315	420	552	306	230	1823
1.4.95	300	364	515	309	227	1715
1.4.96	289	316	475	307	225	1612
1.4.97	277	273	431	301	222	1504
1.4.98	268	236	386	292	219	1401
1.4.99	259	202	340	279	214	1293
1.4.2000	247	167	291	261	206	1171

Table 6.4.5: Manpower Forecast upto 2000 A.D.
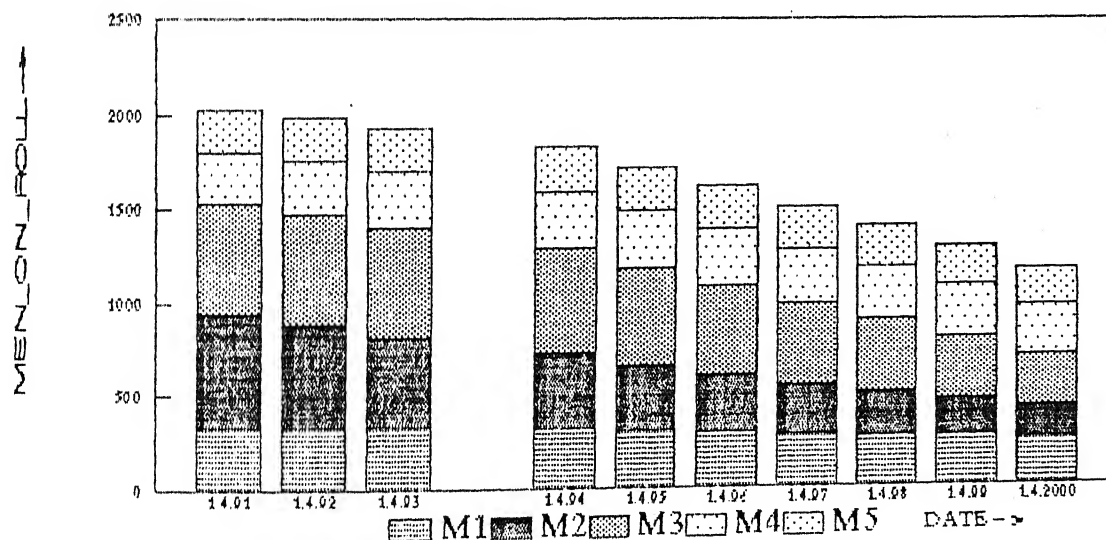
Fig. 6.4.5: Gradewise Manpower Scenario Upto 2000 A.D.

—Manpower decreased in all grades, but more prominent in M2 and M3 grades

a) Policy ALT—5:

HR MANAGEMENT POLICY:

—Inflow through screening into M1 grade =45 individuals p.a.
—Fresh recruits into M1 and M2 grades are 40 and 15 indoviduals p.a. respectively.
—Forced separations are M1 =6, M2=6, M3=3, M4=3, M5=2 individuals p.a.
—Promotion rate of {15%, 15%, 10%, 10%} in M1, M2, M3, and M4 grades
  respectively.

MODEL'S PROJECTION:

DATE	M1	M2	M3	M4	M5	MTOTAL
1.4.91	338	607	588	265	231	2029
1.4.92	349	544	591	283	231	1998
1.4.93	353	489	580	297	232	1951
1.4.94	345	428	550	303	227	1853
1.4.95	337	375	514	305	224	1755
1.4.96	331	332	475	303	221	1662
1.4.97	324	294	433	297	217	1564
1.4.98	319	262	391	288	213	1471
1.4.99	312	232	347	274	207	1373
1.4.2000	303	201	301	257	199	1261

Table 6.4.6: Manpower Forecast upto 2000 A.D.
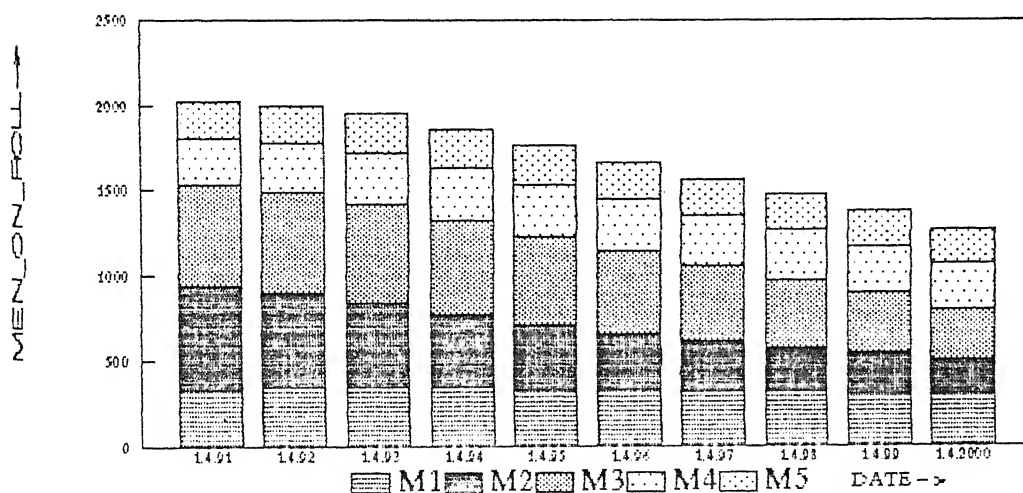
Fig. 6.4.6: Gradewise Manpower Scenario Upto 2000 A.D.

a) Policy ALT-6:

HR MANAGEMENT POLICY:

—Inflow through screening into M1 grade =25 individuals p.a.
—Fresh recruits into M1 and M2 grades are 25 and 10 individuals p.a. respectively.
—No Forced separations.
—Promotion rate of {15%, 15%, 10%, 10%} in M1, M2, M3, and M4 grades respectively.

MODEL'S PROJECTION:

DATE	M1	M2	M3	M4	M5	MTOTAL
1.4.91	338	607	588	265	231	2029
1.4.92	320	545	594	286	233	1978
1.4.93	301	486	586	303	236	1911
1.4.94	273	418	557	312	233	1793
1.4.95	249	357	521	316	232	1675
1.4.96	229	304	481	316	231	1562
1.4.97	212	256	436	312	229	1444
1.4.98	197	214	390	303	227	1331
1.4.99	183	175	342	290	223	1213
1.4.2000	168	135	289	273	216	1081

Table 6.4.7: Manpower Forecast upto 2000 A.D.
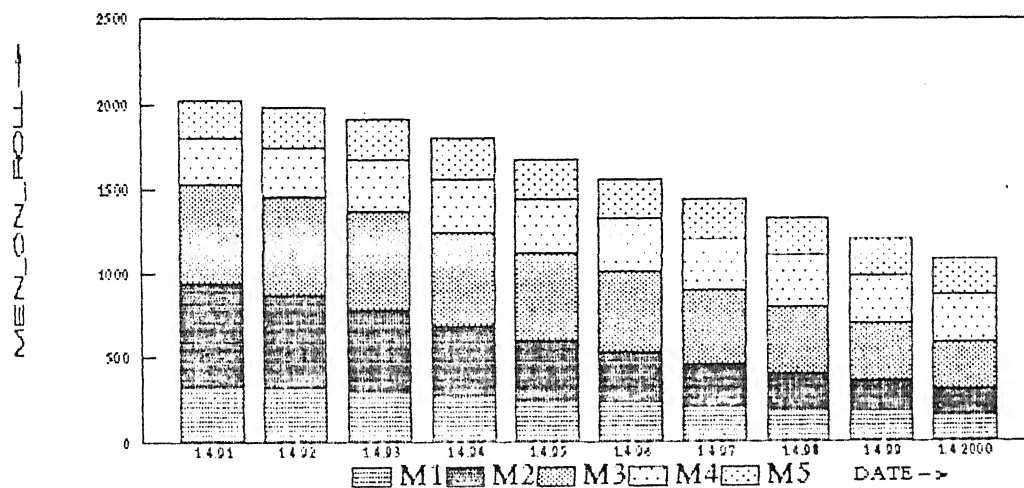
Fig. 6.4.7: Gradewise Manpower Scenario Upto 2000 A.D.

a) Policy ALT−7:

HR MANAGEMENT POLICY:

−Inflow through screening into M1 grade =40 individuals p.a.
−No Fresh recruits into M1 and M2 grades
−No Forced separations and continuing with the existing promotion rate

MODELSOUTPUTS:

DATE	M1	M2	M3	M4	M5	MTOTAL
1.4.91	338	607	588	265	231	2029
1.4.92	308	561	586	268	235	1959
1.4.93	280	512	574	269	238	1874
1.4.94	244	448	546	265	234	1736
1.4.95	214	386	512	258	230	1599
1.4.96	190	328	475	249	225	1467
1.4.97	168	272	433	238	219	1330
1.4.98	150	221	390	226	211	1198
1.4.99	133	171	343	211	203	1060
1.4.2000	115	119	291	193	191	909

Table 6.4.8: Manpower Forecast upto 2000 A.D.
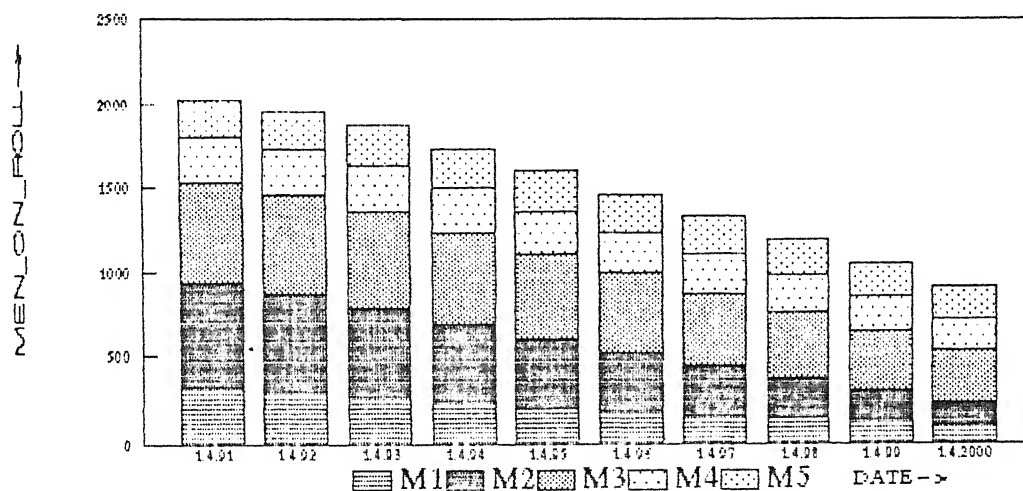
Fig. 6.4.8: Gradewise Manpower Scenario Upto 2000 A.D.

− Sharp decline of manpower in M1, M2, M3 grades

a) Policy ALT-8:

HR MANAGEMENT POLICY:

—No Inflow through screening into M1 grade
—No Fresh recruits into M1 and M2 grades
—No forced separations, and continuing with the existing promotion rate

MODEL'S PROJECTIONS:

DATE	M1	M2	M3	M4	M5	MTOTAL
1.4.91	338	607	588	265	231	2029
1.4.92	268	561	586	268	235	1919
1.4.93	207	505	574	269	238	1794
1.4.94	145	430	544	264	234	1616
1.4.95	93	354	507	257	229	1439
1.4.96	50	280	466	248	223	1267
1.4.97	13	207	418	236	216	1090
1.4.98	0	157	367	222	208	954
1.4.99	0	117	311	205	198	831
1.4.2000	0	76	249	184	184	693

Table 6.4_9: Manpower Forecast upto 2000 A.D.
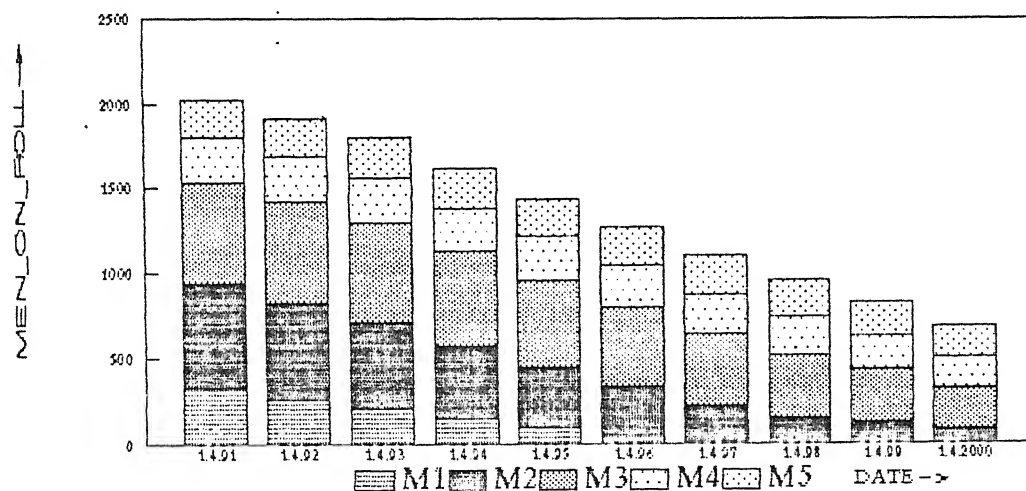
Fig. 6.4.9: Gradewise Manpower Scenario Upto 2000 A.D.

—Population of M1 grade becomes zero by 1997 and also M2 population depletes at fast rate

6.5 SPECIFIC ACTUAL POLICY SHORTFALLS HIGHLIGHTED BY THE PLANNING MODEL.

The above studies completed to evaluate the effectiveness of this model reveal certain critical fitness of the HR policy alternatives contemplated. One key revelation was that the overall manpower trend is in general a declining one with varying slopes for the different inflow and outflow conditions. For instance, the manpower position becomes truly critical if one follows the guidelines as stated in policy "ALT-8", which suggests <u>no inflows</u> to the organization and also <u>no forced separations</u>. As shown in Table 6.4.6, one of the grades would become "empty" by April 1998.

For improving the <u>quality-mix</u> of managerial grade manpower, it would be imperative that there should be inflow of qualified people at M1 and M2 levels. At the same time, restrictions must be imposed on the entry of <u>unqualified</u> persons from supervisory grades to M1 level. Only those with proper qualifications, as per job specifications, should be allowed to enter managerial grades through the screening process. One may also observe, that in order to reduce the total number of managerial population to a smaller target the subject industry should go in for attractive "golden-handshake" packages in order to rid itself of "dead-woods" in the organization. For instance, if the subject organization is not diversifying/expanding, its management should pursue policies such as the following for achieving a <u>target</u> population of approximately 1700 by April 1995, as may be desired. The resulting

decision parameters evolved through experimentation with the proposed model are as follows.

i) Inflow of supervisors into M1 through screening must be maintained at 40 people p.a., fresh recruits of 30 and 10 in M1 and M2 grades respectively, and forced separations of 10 people p.a.. The detailed manpower breakdown is shown in Table 6.4.5 of policy "ALT-4".

ii) The next best alternative appears to be the policy "ALT-6", as described in Table 6.4.7. It says that the inflow through screening should be maintained 25 p.a., fresh recruits of 25 and 10 in M1 and M2 grades respectively, and an increased overall promotion rate (15%, 15%, 10%, and 10%) in the first four M-grades respectively.

6.6 LESSONS LEARNED FROM THE USE OF THE MODEL IN HR POLICY EVALUATION.

Trying with various input parameters, the proposed HR Decision Model would appear to significantly help in predicting the future manpower mix of the subject industry under different scenarios. It should be noted that such evaluations are typically done manually if at all by HR planners. As the number of iterations and input parameters go up, it would be extremely difficult for these planners to manually predict accurately what would be the manpower mix by grades, consequent to adoption of certain specific HR policies by top management. It is expected that the proposed

model-based approach would help bridge the decision "gap" existing here.

In any organization, if one attempts to predict the future scenario of manpower based on past trends only and without really considering the impact of different management inputs (policies) that shape HR management practices, the projections so obtained, might lead to erroneous decisions, and in turn, to stagnation, critical shortages, or higher overall operating costs.

As the business environment changes, a model as the one proposed here could act on the platform to accommodate the changed input parameters. This would help projection of alternative manpower scenarios for evaluation by top management before they select an HR policy based perhaps on intuition or certain rules of thumb.

It also appears imperative that the structure and the logic employed in such model should be carefully explained to the decision makers so that they are able to best exploit its capability. The transition-matrix based model today is amongst the best approaches known to guide decisions related to personnel movements between grades in a large organization.

In the present study several variations of Bartholomew's initial Markov model were considered with the final choice converging on the basic Markov model augmented by an explicit attrition matrix [Table 6.3] to enable direct incorporation of different HR policies.

CHAPTER 7

CONCLUSIONS AND SCOPE FOR FUTURE WORK

7.1 CONCLUSIONS

In this thesis, some enhancements to Markov-type HR (Human resource) Decision Support Models have been proposed, aimed at improving the forecasting of graded manpower population in a large enterprise managed under alternate policies.

The present approach rests on both past (historical) manpower flows between various grades and future HR policies contemplated by management. A Markov-type transition process is assumed to be guiding the past with "transition proportions", as suggested by Bartholomew [6]. Clearly business scenarios do not always follow the earlier years' footsteps; such scenarios are typically turbulent, calling for constant monitoring and the dynamic adjustment of policies. A key objective in HR management is to keep the future projection mix close to real needs. The proposed (expanded) HR decision model incorporates some of these aspects and an explicit, controlled treatment of attritions (page 54) not considered heretofore to facilitate management to explicitly evaluate alternate policies (with their respective input parameters) before zeroing on some particular policy option.

Since policies would attain the model parameters, this model would serve best as <u>decision supporter</u> in the HR planning process of large organizations. This model appear to have performed well for a prototype industry employing 2000 individuals in its management pool and requiring rapid reaction to changes in business, avoidance of stagnation, surplus, and shortage of skilled, graded manpower. The model rapidly highlighted many critical aspects and consequences of different HR policies. Such evaluation would require high level of painstaking manual effort.

The paradigm underlying the model may be expanded to also cover larger number of grades, years of service, lateral transfers, etc., etc.

To facilitate the entry of data required to utilize this model, as a decision support system an HRIS (Human Resource Information System) has been augmented to the model. This would facilitate the recording and tracking of personnel details at various grades. This augmentation provides the conventional supports-easy data updating, query-based menu support as per user's requirements, and quick data retrieval to support various routine HR administration functions. Additionally, it includes appraisal information management, record keeping of skills, and the monitoring of training details of each individual employee.

7.2 SCOPE FOR FUTURE WORK.

i)   The present study has not directly addressed the impact of
qualification mix and performance ratings on the organization's
gradewise manpower structure. This could be done by including
the data on individual employee's appraisal rating and the job
specifications for the different designations in each grades.

ii)   Career Planning and Growth of an employee has been kept out
    of the purview of this model. However, the impact of such
    issues on grade structure could also be studied.

iii) The present model does not test the optimal management
    input-sets in order to arrive at a desired structure
    (gradewise population).   The model could be extended to
    support such needs.

iv)   Both the HR Decision Model and the HRIS were designed
    keeping in perspective the needs of a particular
    organization.   However, these systems may be generalized by
    incorporating suitable additional parameters not contingent
    upon the needs of a specific industry

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APPENDIX

THE ARCHITECTURE, FILES EMPLOYED, AND A TYPICAL USER SESSION WITH THE HRIS

1. PROGRAM LOGIC:

```
                        ┌─────────────────┐
                        │  Main Program   │
                        │  (TELCO. PRG)   │
                        └────────┬────────┘
           ┌─────────────────────┼─────────────────────┐
    ┌──────┴──────┐      ┌────────┴──────────┐    ┌─────┴─────┐
    │  Data Files │      │Utilities Available│    │   Exit    │
    └──────┬──────┘      └────────┬──────────┘    └─────┬─────┘
```

- Employee Master. (SOURCE.PRG)
- Training Database. (TRAINING.PRG)
- Appraisal Database. (APRAISAL.PRG)

- Database files Indexing. (INDEXING.PRG)
- Reports Printing (PRINT.PRG)
- Backup Files to Floppy Disk. (BBACKUP.PRG)
- Restore Files from Floppy Disk. (RESTORE.PRG)

- Return to Dot Promp
- Quit dBASE IV
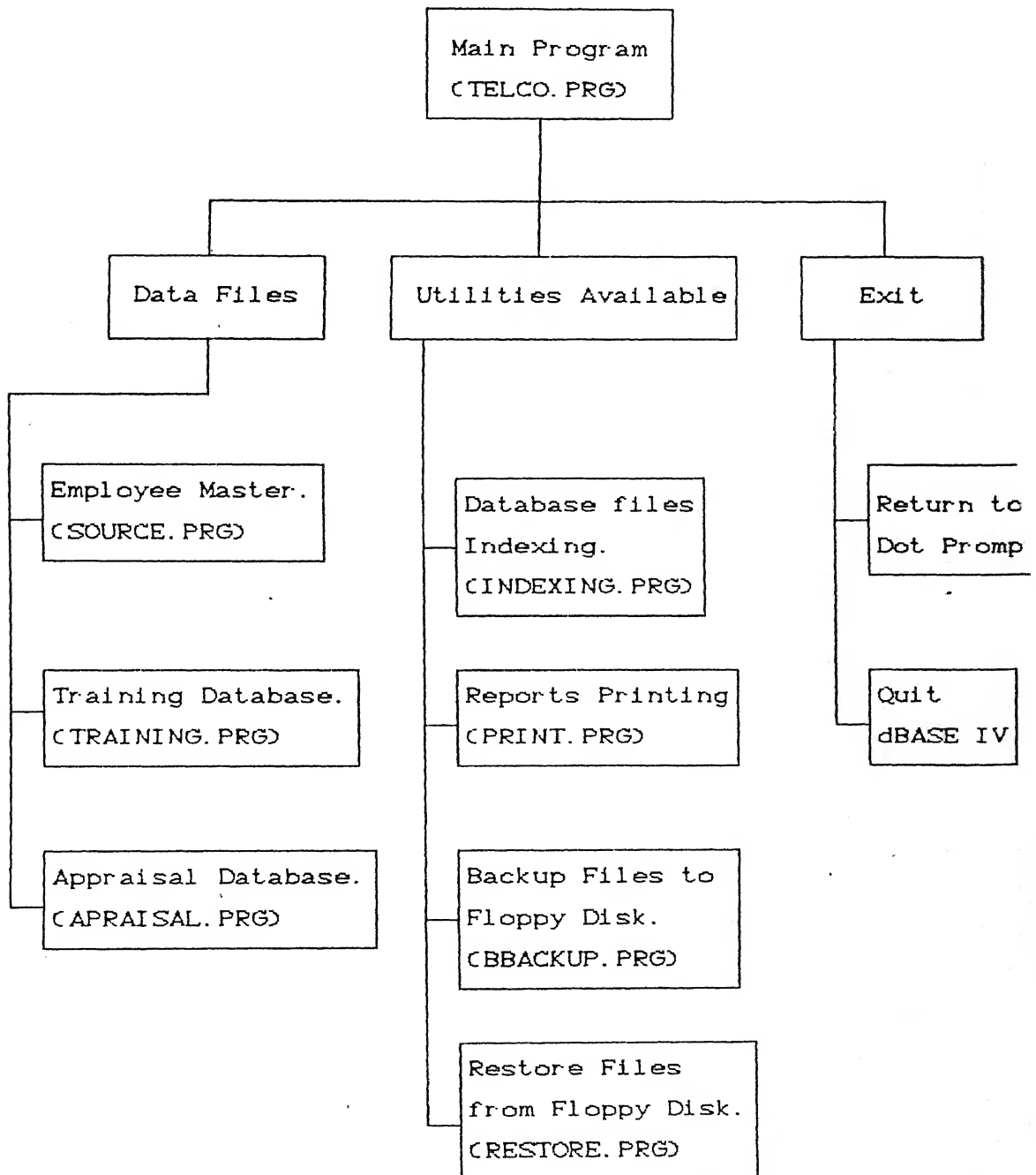
```
┌─────────────────────┐
│ Employee Master     │
│ (SOURCE. PRG)       │
└─────────────────────┘
              │
              │    ┌──────────────────────────┐
              │    │ Add an Employee Record   │
              ├────│ to Source Data file      │
              │    │ (ADDNEW. PRG)            │
              │    └──────────────────────────┘
              │
              │    ┌──────────────────────────┐
              │    │ Update a Record          │
              ├────│ (EDITS. PRG)             │
              │    └──────────────────────────┘
              │
              │    ┌──────────────────────────┐
              │    │ Delete a Record          │
              ├────│ (ERASER. PRG)            │
              │    └──────────────────────────┘
              │
              │    ┌──────────────────────────┐
              │    │ Find Details as Desired  │
              └────│ (FINDS. PRG)             │
                   └──────────────────────────┘
```

Find Details about an
Employee.
(QEMP. PRG)

Gradewise Men-On-Roll
of a Department.
(DEPT_MEN. PRG)

Gradewise Men-On-Roll
of a Division.
(DIV_MEN. PRG)

Gradewise Manpower
of an enterprise.
(SUMMARY. PRG)

Update an Employee
Record through
Promotion.
(PROMOTE. PRG)

Update an Employee
Record through
Transfer.
(TRANSFER. PRG)

Update Employee
Qualification
(QUAL. PRG)

```
┌─────────────────────┐
│ Training            │
│ Database            │
│ (TRAINING.PRG)      │
└─────────────────────┘
```

```
┌──────────────────────────────┐
│ Update Training Record of    │
│ an Employee.                 │
│ (ADDTRG.PRG)                 │
└──────────────────────────────┘
```

```
┌──────────────────────────────┐
│ Find Training Details        │
│ (TRG_QRY.PRG)                │
└──────────────────────────────┘
```

— Find Training Details of
  an Employee.
  (QEMP_TRG.PRG)

└─ Find Details of Participants
   and Venues for a particular
   Training Programme.
   (QPRO_TRG.PRG)

```
┌─────────────────┐
│ Apraisal        │
│ Database.       │
│ (APRAISAL.PRG)  │
└─────────────────┘
              │
              │    ┌──────────────────────────────────────┐
              │    │ Add Appraisal Record of an Employee   │
              ├────│ to Appraisal Database.                │
              │    │ (APRL_ADD.PRG)                        │
              │    └──────────────────────────────────────┘
              │
              │    ┌──────────────────────────────────────┐
              │    │ Find Details from Appraisal Database  │
              └────│ (FINDAPRL.PRG)                        │
                   └──────────────────────────────────────┘
                         │
                         │    ── Find Appraisal Traits of an
                         │       Employee.
                         │       (APRL_EMP.PRG)
                         │
                         │    ── Find Skills of an Employee.
                         │       (APRL_SKL.PRG)
                         │
                         └──── Find Appraisal Summary
                                 for any year.
                                 (APRL_SUM.PRG)
```

```
┌─────────────────────┐
│ Reports Printing    │────────┐
│ (PRINT.PRG)         │        │
└─────────────────────┘        │
                               │
                               │    ┌─────────────────────┐
                               ├────│ Manpower  Reports   │
                               │    └─────────────────────┘
                               │
                               │    ┌─────────────────────┐
                               ├────│ Training  Reports   │
                               │    └─────────────────────┘
                               │
                               │    ┌─────────────────────┐
                               ├────│ Appraisal  Reports  │
                               │    └─────────────────────┘
                               │
                               │    ┌─────────────────────┐
                               └────│ Skill  Reports      │
                                    └─────────────────────┘
```

2. DATABASE FILE STRUCTURE

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\SOURCE.DBF
Number of data records:        4
Date of last update   : 26/11/91
Field  Field Name   Type         Width    Dec    Index
    1  TICKET_NO    Character       5              Y
    2  DEPT_CODE    Character       4              N
    3  CLSFN_CODE   Character       1              N
    4  EMP_NAME     Character      20              N
    5  EMP_GRADE    Character       2              N
    6  DSGN_CODE    Character       4              N
    7  BIRTH_DATE   Date            8              N
    8  APPRNT_DT    Date            8              N
    9  APPNT_DATE   Date            8              N
   10  LAST_PROM    Date            8              N
   11  QUAL_BASIC   Character       1              N
   12  QUAL_PROF    Character       2              N
   13  QUAL_TRG     Character       2              N
** Total **                       74
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\BC.DBF
Number of data records:      354
Date of last update   : 12/02/91
Field  Field Name   Type         Width    Dec    Index
    1  DEPT_CODE    Character       4              Y
    2  DEPT_DESC    Character      20              N
    3  IRS_CODE     Character       2              N
    4  MNDIV_CODE   Character       1              N
** Total **                       28
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\CLASS.DBF
Number of data records:        2
Date of last update   : 02/06/91
Field  Field Name   Type         Width    Dec    Index
    1  CLSFN_CODE   Character       1              N
    2  CLSFN_DESC   Character      10              N
** Total **                       12
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\IRS.DBF
Number of data records:      48
Date of last update   : 10/02/91
Field   Field Name   Type        Width    Dec    Index
   1    IRS_CODE     Character      2              Y
   2    IRS_DESC     Character     22              N
** Total **       :                25
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\MANDIV.DBF
Number of data records:       7
Date of last update   : 25/11/91
Field   Field Name   Type        Width    Dec    Index
   1    MNDIV_CODE   Character      1              N
   2    MPDIV_DESC   Character     20              N
** Total **                       22
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\DESIGNAT.DBF
Number of data records:     109
Date of last update   : 06/02/91
Field   Field Name   Type        Width    Dec    Index
   1    DSGN_CODE    Character      4              N
   2    DSGN_DESC    Character     35              N
** Total **                       40
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\BAS_QUAL.DBF
Number of data records:      10
Date of last update   : 06/02/91
Field   Field Name   Type        Width    Dec    Index
   1    BQ_CODE      Character      1              N
   2    BQ_DESC      Character     20              N
** Total **                       22
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\PROF_QUA.DB
Number of data records:     100
Date of last update   : 06/02/91
Field   Field Name   Type        Width    Dec    Index
   1    PQ_CODE      Character      2              N
   2    PQ_DESC      Character     30              N
   3    MAJ_GROUP    Character      1              N
** Total **                       34
```

```
Structure for database:  E:\USER\STUDENT\SKR\THESIS\DBASE4\TRG_QUAL.DBF
Number of data records:        4
Date of last update   : 17/02/91
Field   Field Name   Type        Width    Dec    Index
    1   TQ_CODE      Character      2             Y
    2   TQ_DESC      Character     25             N
** Total **                       28
```

```
Structure for database:  E:\USER\STUDENT\SKR\THESIS\DBASE4\TRAINING.DBF
Number of data records:       40
Date of last update   : 26/11/91
Field   Field Name   Type        Width    Dec    Index
    1   TICKET_NO    Character      5             Y
    2   SUB_CODE     Character      3             Y
    3   ATTEND_DT    Date           8             N
    4   DURATION     Numeric        4      1      N
    5   VENUE_CODE   Character      3             N
** Total **                       24
```

```
Structure for database:  E:\USER\STUDENT\SKR\THESIS\DBASE4\SUBJECT.DBF
Number of data records:       10
Date of last update   : 10/02/91
Field   Field Name   Type        Width    Dec    Index
    1   SUB_CODE     Character      3             Y
    2   SUB_DESC     Character     20             N
** Total **                       24
```

```
Structure for database:  E:\USER\STUDENT\SKR\THESIS\DBASE4\VENUE.DBF
Number of data records:       10
Date of last update   : 10/02/91
Field   Field Name   Type        Width    Dec    Index
    1   VENUE_CODE   Character      3             Y
    2   VENUE_DESC   Character     20             N
    3   CITY         Character     20             N
    4   PIN          Character      6             N
** Total **                       50
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\PROMOTE.DBF
Number of data records:       41
Date of last update    : 26/11/91
Field  Field Name  Type        Width   Dec   Index
    1  TICKET_NO   Character       5               N
    2  DT_OF_PROM  Date            8               N
    3  TO_GRADE    Character       2               N
    4  TO_BC_CODE  Character       4               N
    5  TO_DSGCODE  Character       4               N
** Total **                      24
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\TRANSFER.DBF
Number of data records:       19
Date of last update    : 26/11/91
Field  Field Name  Type        Width   Dec   Index
    1  TICKET_NO   Character       5               N
    2  DT_OF_TRFR  Date            8               N
    3  TO_BC_CODE  Character       4               N
    4  TO_DSGCODE  Character       4               N
** Total **                      22
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\SEPARATE.DBF
Number of data records:       17
Date of last update    : 26/11/91
Field  Field Name  Type        Width   Dec   Index
    1  TICKET_NO   Character       5               Y
    2  DT_OF_SEPN  Date            8               N
    3  SEPN_CODE   Character       2               N
** Total **                      16
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\SEP_CODE.DBF
Number of data records:       14
Date of last update    : 26/11/91
Field  Field Name  Type        Width   Dec   Index
    1  SEPN_CODE   Character       2               Y
    2  SEPN_DESC   Character      23               N
** Total **                      26
```

```
Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\APRAISAL.DBF
Number of data records:        18
Date of last update    : 26/11/91
Field  Field Name   Type         Width    Dec    Index
    1   TICKET_NO    Character       5             Y
    2   DATE_APSRL   Date            8             Y
    3   APRSL_TYPE   Character       1             N
    4   TRAIT_1      Character       1             N
    5   TRAIT_2      Character       1             N
    6   TRAIT_3      Character       1             N
    7   TRAIT_4      Character       1             N
    8   TRAIT_5      Character       1             N
    9   TRAIT_6      Character       1             N
   10   TRAIT_7      Character       1             N
   11   TRAIT_8      Character       1             N
   12   TRAIT_9      Character       1             N
   13   TRAIT_10     Character       1             N
   14   OVRL_RAT     Character       1             N
   15   SKILCODE     Character       3             N
** Total **                        29


Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\SKILL.DBF
Number of data records:        0
Date of last update    : 25/11/91
Field  Field Name   Type         Width    Dec    Index
    1   TICKET_NO    Character       5             N
    2   DATE_APSRL   Date            8             N
    3   SKILL_CODE   Character      20             N
** Total **                        34


Structure for database: E:\USER\STUDENT\SKR\THESIS\DBASE4\SKL_CODE.DBF
Number of data records:        9
Date of last update    : 08/02/91
Field  Field Name   Type         Width    Dec    Index
    1   SKILCODE     Character       3             Y
    2   SKILL_DESC   Character      20             N
** Total **                        24
```

A TYPICAL USER SESSION PROGRESSES THROUGH THE FOLLOWING USER
INTERFACE SCREENS:

```
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: HRIS Telco HRI:                                          :elco HRIS Telco
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ZDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD?
3          E M P L O Y E E    D A T A    E N T R Y     S C R E E N          3
3                                                                          3
3DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD3
3 B.C. NUMBER  1113     EMPLOYEE TICKET NO.  00005    CLASSIFICATION CODE  1 3
3                                                                          3
3 NAME  OF  THE  EMPLOYEE    XYZABCDEF            EMPLOYEE GRADE  M1         3
3DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD3
3                                      3                                    3
3            DATE OF BIRTH   10/10/40  3        DESIGNATION CODE    9100     3
3                                      3                                    3
3    DATE OF APPOINTMENT     10/10/65  3       BASIC QUALIFICATION    3      3
3                                      3                                    3
3     DATE OF APPRENTICE     01/01/66  3   PROFESSIONAL QUALIFICATION  09    3
3                                      3                                    3
3 DATE OF LAST PROMOTION     01/01/90  3      TRAINING QUALIFICATION   01    3
3                                      3                                    3
@DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD!
```

Please Check Your Entries ONCE AGAIN Before Saving The Data

Press any key to contiue ..

```
IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
:                                       :
: DATA ENTRY SCREEN FOR PROMOTION DETAILS :
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD:
:                                       :
:     TICKET NO. OF THE EMPLOYEE  00005  :
:                                       :
:                                       :
:       DATE OF PROMOTION  01/01/91      :
:                                       :
:       PROMOTED TO GRADE  M2            :
:                                       :
:     NEW DESIGNATION CODE  9200         :
:                                       :
:          NEW B.C. IF ANY  1119         :
HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM<
```

Please Check Your Entries ONCE AGAIN Before Saving The Data

                                    Press any key to contiue


```
IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
:                                        :
:  DATA ENTRY SCREEN FOR TRANSFER DETAILS :
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD:
:                                        :
:    TICKET NO. OF THE EMPLOYEE  00005    :
:                                        :
:      DATE OF TRANSFER   01/02/91        :
:                                        :
:     TRANSFERREDTO NEW B.C. 1190         :
:                                        :
:    NEW DESIGNATION CODE IF ANY  9201    :
:                                        :
HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM<
```


                                    SURE TO SAVE THIS DATA (Y/N) ?

```
IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
: DATA ENTRY SCREEN FOR UPDATING QUALIFICATIONS :
: ================================================ :
:                                                  :
:        TICKET NO. OF THE EMPLOYEE   00005        :
:                                                  :
:                                                  :
:              BASIC QUALIFICATION CODE      4     :
:                                                  :
:                                                  :
:        PROFESSIONAL QUALIFICATION CODE     10    :
:                                                  :
:                                                  :
:              TRAINING QUALIFICATION CODE   01    :
:                                                  :
:                                                  :
HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM<
```

EXISTING QUALIFICATION CODES ARE AS DISPLAYED ABOVE

```
IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
:                                                  :
: DATA ENTRY SCREEN FOR SEPARATION OF EMPLOYEES    :
:                                                  :
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD:
:                                                  :
:        TICKET NO. OF THE EMPLOYEE   00002        :
:                                                  :
:        EFFECTIVE DATE OF SEPARATION  01/11/91    :
:                                                  :
:                SEPARATION CODE                   :
:                                                  :
HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM<
```

```
ZDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
3            SEPARATION    CODE       3                    DESCRIPTION
3DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD3DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
3                 01                  3            SUPERANNUATION
@DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
              Use Up & Down key to Select your option
```

```
DETAILS OF THE EMPLOYEE
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD:

              FULL TICKET NO  6813/17106/1

         NAME  PETER THOMAS              GRADE  M2

      DESIGNATION

: DEPARTMENT  AXLE IED              DIVISION  INDUSTRIAL ENGG

            DATE OF BIRTH  01/01/59     AGE IN YEARS  32.9

        DATE OF APPOINTMENT  11/02/81  YEARS OF SERVICE  10.8

        LAST PROMOTION DATE  01/01/91   YEARS IN GRADE   0.9
```

Press Any Key To Continue...

```
IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
:       BASIC QUALIFICATION          INTER                           :

:PROFESSIONAL QUALIFICATION          B TECH                          :

:    TRAINING QUALIFICATION          GRADUATE  ENGG.  TRAINEE        :
```

```
IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
: DATA ENTRY SCREEN FOR TRAINING DETAILS :
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD:
:                                        :
:     TICKET NO. OF EMPLOYEE    17106     :
:                                        :
:     SUBJECT CODE OF TRAINING  001       :
:                                        :
:       STARTING DATE     01/01/91        :
:                                        :
:TRAINING PERIOD  12.0   VENUE CODE   001 :
HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM<
```

```
IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMI
:
:                       EMPLOYEE TRAINING DETAILS
:
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD:
:
:         FULL TICKET NO.  :   6813/17106/1         GRADE : M2
:
:     NAME : PETER THOMAS                DIVISION : INDUSTRIAL ENGG
:MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
:                       3              3              3
:        PROGRAMME      3  Dt.ATTENDED  3  DURATION    3          VENUE
:                       3              3  (in days)   3
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
:                       3              3              3
: VIBRATION             3  12/12/90     3   34.0       3  IIT
: CAD                   3  19/11/90     3    8.0       3  TELCO
: QUALITY CIRCLE        3  19/12/88     3    2.0       3  IIT, MADRAS
: CAD                   3  12/12/90     3    2.0       3  XIS
: QUALITY CIRCLE        3  12/12/90     3    8.0       3  ADMN. STAFF COLLEGE
: CAD                   3  11/01/91     3    1.0       3  IIT, KANPUR
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                    PRESS ANY KEY TO PROCEED

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IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM;
:            DATA ENTRY SCREEN FOR APPRAISAL DETAILS          :
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD:
:                                                             :
:      FULL TICKET NO.   1190/00005/1      GRADE :   M2       :
:                                                             :
:                  NAME :  XYZABCDEF                          :
:                                                             :
:   DATE OF APPRAISAL   01/04/91    APPRAISAL TYPE            :
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD:
:                                                             :
:  TRAIT-1         TRAIT-2         TRAIT-3         TRAIT-4     :
:                                                             :
:  TRAIT-5         TRAIT-6         TRAIT-7         TRAIT-8     :
:                                                             :
:     TRAIT-9         TRAIT-10        OVERALL RATING          :
:                                                             :
:                    SKILL   CODE                             :
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                SAVE   THIS   DATA   (Y/N)   T
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```
IMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
:      M A N P O W E R        S U M M A R Y       AS ON : 26/11/91
:DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
:     GRADE 3DEGREE IN ENGG  DIPLOMA  CERTIFICATE   OTHERS  3 TOTAL
:           3   & ABOVE                                     3
:      -----3----------------  ---------  ------------  ---------3 ----------
:           3                                              3
:     M1           0            0           0            0        0
:           3                                             3
:     M2           2            1           0            0        3
:           3                                              3
:     M3           0            0           0            0        0
:           3                                              3
:     M4           0            0           0            1        1
:           3                                              3
:     M5           0            0           0            0        0
:DDDDDDDDDDDEDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDEDDDDDD
:     TOTAL        2            1           0            1        4
HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
```

ress any key to continue....

ACTUAL MEN_ON_ROLL   VS.   PROJECTED MEN_ON_ROLL

Date		M1	M2	M3	M4	M5	Mtot
01.04.84	On_Roll	575	751	472	225	190	2213
	Projected	571	754	476	221	188	2210
01.04.85	On_Roll	584	757	482	232	193	2248
	Projected	581	756	480	229	196	2242
01.04.86	On_Roll	519	746	533	208	217	2223
	Projected	520	747	532	212	214	2225
01.04.87	On_Roll	511	707	558	228	212	2216
	Projected	514	711	562	222	217	2226
01.04.88	On_Roll	474	654	583	246	218	2175
	Projected	478	660	585	248	212	2183
01.04.89	On_Roll	453	582	589	252	224	2100
	Projected	449	586	593	258	221	2107
01.04.90	On_Roll	386	583	576	257	224	2020
	Projected	382	588	572	259	229	2030
01.04.91	On_Roll	338	607	588	265	231	2020
	Projected	342	601	592	267	235	2030